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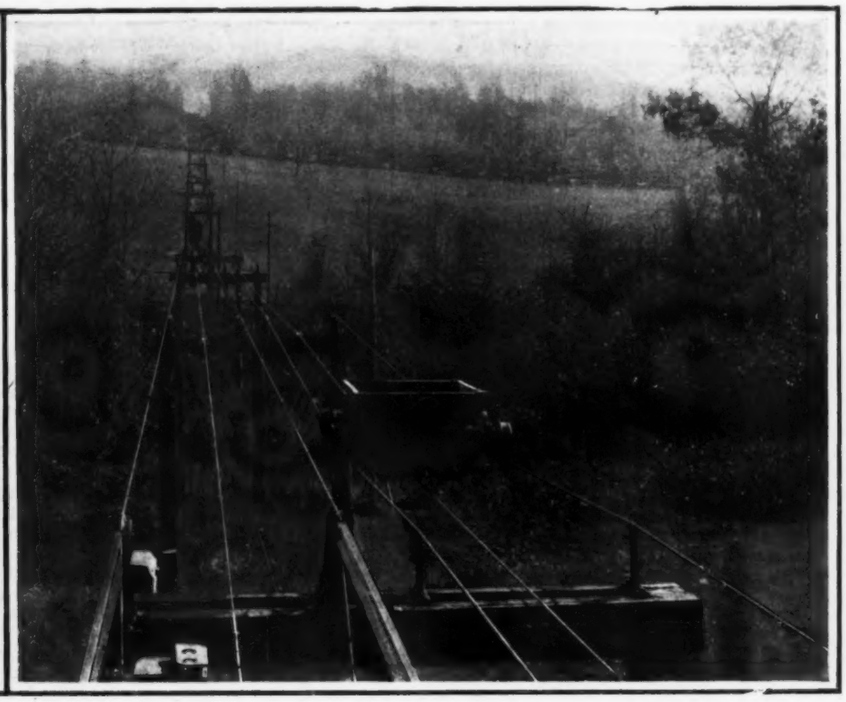
A CABLE SUPPORT OF THE AERIAL TRAMWAY.



THE TRAMWAY RUNNING UP A FOUR PER CENT GRADE NEAR GREENVILLE, VA.

ARRANGEMENT OF THE CAR AT THE LOADING TERMINAL OF A LOOPED SECTION AERIAL TRAMWAY IN FRANKLIN COUNTY, VA. CAPACITY, 100 CORDS PER DAY.

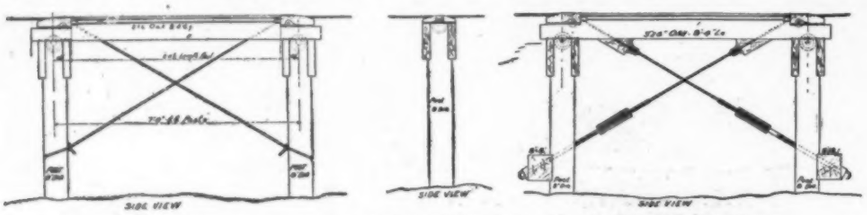
UP-TO-DATE SHORT-DISTANCE TRANSPORTATION.

SHORT-DISTANCE TRANSPORTATION.

A MODERN FREIGHT CONVEYING SYSTEM.

BY FRANK C. PERKINS.

IT may be stated that by short-distance transportation is meant the handling of products of the mine, field, and forest from the outlying districts to the railroad; and this is one of the greatest industrial problems of the age, and has required much careful study and great engineering skill in its solution. This problem has become more serious during the recent year, as the railways have been rapidly exhausting the tonnage near their lines, and the construction of branch or spur lines to outlying districts by the railroad companies has frequently proven unprofitable, as the cost of construction and equipment is heavy where a method of transportation required leveling to a greater or less extent over the whole route to be traveled.



ANCHOR SECTION SUPPORT INTERMEDIATE SUPPORT LOOPED SECTION SUPPORT

The distance between an Anchor Section and a Looped Section is about 600 feet with five or six intermediate supports.

CONSTRUCTIONAL DETAILS OF A LOOPED SECTION AERIAL TRAMWAY.

Branch or spur railway lines require in many cases a greater expenditure of capital than the amount of tonnage will justify, particularly where these branches may have to be abandoned within a few years because the tonnage has been exhausted to a degree which necessitates the discontinuance of operation; and therefore the solution of the problem of short-distance transportation lies in the provision of a suitable track surface of low cost and maintenance, on which cars may be used which are adapted for hauling the particular kind of tonnage to be carried.

The accompanying illustrations show the equipment and some of the improved methods of transportation which measure up to these requirements, with low cost of construction, maintenance, and operation, and the least amount of friction for the movement of the car. The construction of a looped section aerial tramway is illustrated in the line cut, while one of the photographs shows the cable support, which consists of 2 by 10 plank bolted across the top, the stress on the same being always vertical, as the loads pass directly over the support instead of at the side. It is stated that the cost of a looped section tramway ranges from $750 to $3,000 per mile. It is obvious, if tonnage is to be moved over a rough country, necessitating the crossing of mountains, deep ravines, and streams, that such a tramway offers a very cheap method of track building. No expensive rolling stock is required, no train crews are necessary, no grading has to be done, and no wrecks due to washouts can occur.

The tramway is especially adapted to the transportation of lumber, coal, ore, tan bark, cord wood, cross ties, sand, and crushed stone for distances ranging from a few hundred yards to four or five miles. Its carrying capacity ranges from 10,000 to 50,000 feet of lumber, or from 50 to 250 tons of ore or other material per day, a ⅜-inch cable being ample for the former, while a ⅝-inch cable is adequate for the latter capacity. The cables used by this system cost from two to five cents per foot, because comparatively small cables are employed without thereby relatively decreasing carrying capacity. This result is attained by constructing the track in a series of looped sections, wherein the track cables are anchored at one support, run 500 to 600 feet to the next support, down under a tension pulley and back to the starting point, thereby forming both sides of the track of the same rope, and automatically adjusting the tension. It will thus be seen that each section is entirely independent of the others, but is so arranged as to admit of a continuous and uninterrupted passage of the cars from one section to another along the entire tramway.

The track is supported every hundred feet when convenient, and the supports here, as at the looped sections, are merely posts planted like telephone poles or fence posts, with 2 x 8 plank bolted across the top to carry the cable supports. Specially designed supports carry the car from section to section, and take the weight of the car off the rope at the points where it is stiffly supported, thus prolonging its life.

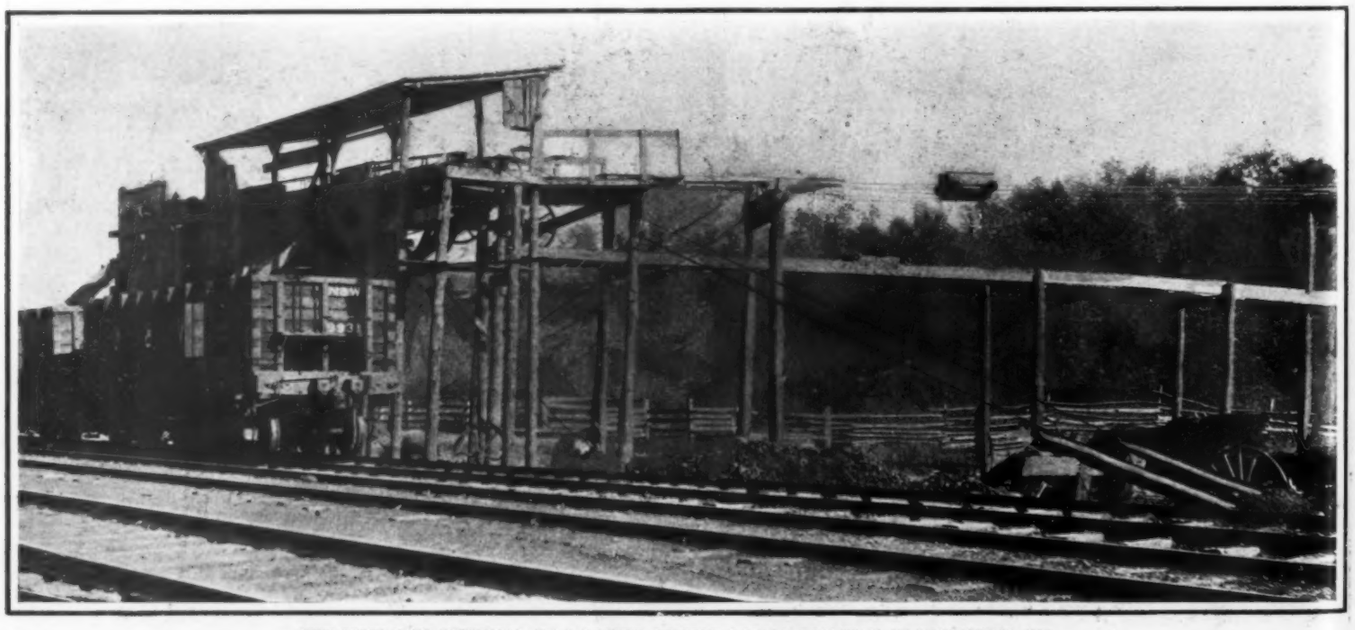
The power is supplied by a revolving drum, which drives an endless rope along the center of one track and back along the center of the other. This power rope is guided by idlers, and at curves these idlers are placed inside the center line. At each terminal the cars run from or to special rails, and are automatically gripped to or released from the hauling cable; they may there be run by hand to any convenient place for dumping or filling.

While the looped section cableway system is undoubtedly a very cheap and practical method for transporting certain kinds of material over rough mountainous districts, it is not adapted to the transportation of saw logs, telegraph poles, or other very heavy, unwieldy tonnage, nor is it suitable for the transportation of passengers, farm products, and merchandise generally. In such cases a motor railway may be constructed by planting 8 x 8 posts 32 feet apart, and attaching to these posts a specially designed rail having great supporting power in proportion to its weight.

Between these posts two or three lighter posts or supports are placed, to insure absolute rigidity of rails under all loads the road is designed to carry. In this construction no grading has to be done, the grade being secured by the use of longer or shorter posts; neither are the cross ties necessary, for the reason that a specially designed gage rod connects the track at each rail splice, and the use of double flange or sheave wheels on cars and motors effectually prevents any tendency of spreading of rails. The power may be supplied either by an endless hauling cable, or if the line exceeds four or five miles in length and the grade will permit, the power will be supplied by gasoline motors constructed along the same lines as those in use to propel automobiles.

This motor railway, therefore, is designed not only to transport all kinds of tonnage, but also as a permanent road to connect outlying towns and rural districts with the railroads. It will serve all the purposes in such cases as would a standard gage railway, and will give even more satisfactory service, for the reason that the light nature of the equipment makes it possible to stop anywhere along the line to take on or let off freight and passengers.

It is held that another very important feature of these systems is the ease with which they can be combined so as to form a continuous line over a route which would preclude the use of either system separately for the entire distance. For instance, if it should be desired to provide transportation facilities for a district lying some 15 or 20 miles from a railway, but separated from the same by a high mountain, a motor railway could be built to the foot of the mountain, and the cars carried over the mountain by the cable haulage system. The light nature of the equipment, and the fact that the double flange or sheave wheels are used in both systems, would enable this to be done with ease and dispatch.



THE DISCHARGE TERMINAL OF A LOOPED SECTION AERIAL TRAMWAY AT BALTIMORE, MD.

UP-TO-DATE SHORT-DISTANCE TRANSPORTATION.

DRY AIR IN THE BLAST FURNACE.

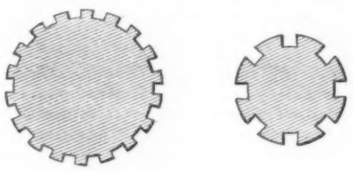
THE GAYLEY PROCESS.

THE use of dry air in the blast furnace, as patented by Mr. Gayley, has been described and discussed in the United States, England, Germany—everywhere, indeed, that pig iron is made.

At the Chattanooga meeting of the American Institute of Mining Engineers held in the first week of October last a paper was read on "The Gayley Dry Blast at the Warwick Furnaces, Pottstown, Pa.," by Mr. Edward Cook, one of the managers. This paper contains a great deal of interesting and suggestive information. Before dealing with it, it is expedient to say a few words concerning blast furnace practice. The theory of the blast furnace has received much attention, and it is supposed that nothing remains to be learned concerning it. This, however, is clearly enough a mistake. Thus, for example, the influence of weather on the quality of the iron made is fully recognized. But we have never yet seen an approach to a generally accepted and complete explanation of the reason why, for example, when the wind is in one quarter white iron is made and in another quarter gray iron. Let it be kept in mind that there are plenty of explanations; it is not of that we complain, but rather that there are far too many. It has long been known that the amount of moisture in the air has an effect on the working of a furnace. The complete explanation of the reason why has yet to be formulated. The truth is that the practical working of a blast furnace is a singularly delicate operation, depending for success not only on several factors which are quite well understood, but on the interaction of those factors which are not understood at all—that is to say, in the sense that intended results can always be secured. We learn from Mr. Cook that much attention had been paid at the Warwick furnaces to the effect of "aqueous vapor" on the output, both as regards quality and quantity. He told his hearers that it had been found impossible to make a satisfactory percentage of high silicon foundry iron in summer, even on a large fuel consumption, and for some years the endeavor had been made so to arrange the sales that during July and August only a small percentage of the iron produced would be required to carry more than 2 per cent silicon. A larger furnace, running on basic iron, year after year, produced in February a tonnage 20 per cent higher than in August on a much lower fuel consumption, while, at the same time, the summer months were marked by scaffolding, tuyeres closed by slips, and other irregularities, constituting serious additional business losses. These things strongly disposed the managers to try the Gayley system.

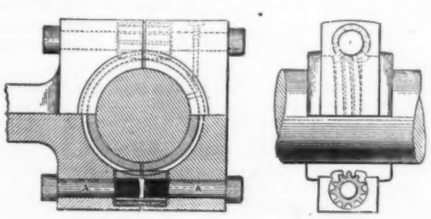
Before going further it is necessary to call attention to the words aqueous vapor, which we have put in quotation marks above. It appears to us that the presence of aqueous vapor is incompatible with the working conditions. This is the crux of the whole problem. If the few grains of water in a cubic foot of air were blown directly into a furnace, we could understand that a cooling effect might be produced; but it would be a mere trifle when compared with the quantity of fuel being burned in an hour, a minute, or a day. But the aqueous vapor suspended in the air has to pass through a stove where the air is raised to a temperature of at least 1,200 deg. F., probably much more. Water could not exist as such in this stove. It would be converted into superheated steam to the last drop. The most that the dry air process in this direction can do is to reduce the minute quantity of superheated steam already going into the furnace until it becomes almost a vanishing quantity. What effect can a few cubic feet of highly superheated steam have on the chemical changes and heat transfers going on inside the furnace? Thermodynamically it does not appear that it can have anything more than an utterly insignificant effect. But that there is an effect produced by drying the blast, and that an important effect, seems to be beyond dispute. The temperature of the furnace is very largely increased, no one knows why. The most convincing explanation to our mind is that the engines working on cold air can send a greater weight per stroke into the furnace than would be possible if they worked on warm air; but this explanation has, we understand, been rejected by Mr. Gayley. The reasons why the process is successful given by Mr. Cook take entirely different ground. He does not make any attempt to explain the rise in temperature, and he gives an hypothesis which he says "satisfies us." We give it in his own words because we fail to fully understand them. "Of all the heat value of coke that goes into a furnace," he writes, "only about one-fourth is available for heating the hearth, about one-half is sensible heat in the gas, about one-quarter reduces the ore, some is required to carburize the iron. Now the hearth is the only limit, the only place where the ordinary furnace requires more heat. It was estimated for years that dry blast would save only 3 per cent of coke, but the fact was neglected that this 3 per cent of the total fuel would be saved to the hearth alone, and that this would amount to four times as much—that is, 12 per cent of the heat of the hearth—and as the hearth is the only weak place, the efficiency of the furnace would be increased 12 per cent. The dry blast decreases the duty of the hearth 12 per cent, and allows the resultant heat to be utilized upon increased quantities of iron and slag. Therefore the furnace will carry a heavier burthen."

Here we must leave this section of the paper, and turn to the results obtained by putting dry blast on to the smaller of two furnaces; as recorded by Mr.



GROOVED MOTOR CAR SHAFTS OVER WHICH HUBS WITH CORRESPONDING GROOVES FIT.

Cook, they appear to be have been disastrous at first. Nothing but trouble followed. The inside of the furnace was almost worn out before the experiment was tried. Scaffolding took place; the contents of the furnace ran together so that the blast could not get through the tuyeres even when the pillar rose to 25 pounds per square inch, and the blowing engines were pulled up. The trouble was ultimately got over by augmenting the burthen. Then No. 1 furnace was relined, and Mr. Cook gives a detailed account of its working, and is quite satisfied now with the result. According to English notions the plant is over-driven, the output being as much as 1700 tons of iron per week. Here and there in the course of the paper we come upon statements which go to support our view that the gain is due to the greater density of the blast and not to the reduction in moisture—that is to say, the output of the blowing engine is increased. Thus we read: "The revolutions of the engine were reduced 10 per cent and the burthen increased 5 per cent"; and again: "The dry blast plant is about 150 feet from the No. 1 blowing engine, and the pipe is not protected from the sun. The temperature of the air arriving at the engine varies about 15 degrees in summer, between day and night. This makes a difference of, roughly, 5 per cent in the volume of air that the blowing engine delivers. The effect upon the furnace is to make her drive about 5 per cent faster at night." This appears to be fairly conclusive proof of the accuracy of the views which we have always held about the Gayley process, namely, either there is some factor in the chemistry of the blast furnace not understood—which is quite possible—or else the presence or absence of a small quantity of super-



ROD CONNECTION IN WHICH THE WEAR OF THE BRASSES IS AUTOMATICALLY TAKEN UP.

heated steam can have no material effect on the output of a furnace either in quantity or quality. By cooling the air admitted to a blowing tub the weight of air which a given plant can deliver per minute to the stoves and thence to the furnace may be largely augmented. It is this augmentation in the weight of air delivered that mainly accounts for the faster working of the furnace. The fact that a distinct saving in the quantity of coke required to make a ton of pig iron is much diminished remains to be explained. It is probable that with a higher temperature there is a more energetic chemical action, and, according to Mr. Cook, there is also a better distribution of the heat in the furnace. We have nothing whatever to urge against the Gayley process; but it would be comforting if a satisfactory explanation of its theory and practice, which would be generally acceptable and accepted, could be advanced by a dispassionate man whose authority, both as a chemist and an ironmaker, would be universally recognized. At present the practical advantage of it can only be explained by saying that it standardizes the condition as far as humidity is concerned of the blast. Uncertain atmospheric irregularities are removed, and the furnace works under constant and invariable conditions. Hence much of the improvement.—Engineer (London).

GROOVED SHAFTS FOR MOTOR CARS.

THE Lanchester Motor Company, Ltd., of Birmingham, England, employs a rather interesting means of securing driving parts of automobiles to their respective shafts. The principle employed is clearly illustrated by the two sections of shafts shown in the accompanying cut. The shafts are grooved as indicated, and the corresponding female parts are provided with grooves to fit. This system of connecting the shafts with the rotating parts was adopted by this company over eight years ago, and has stood the test of long time of service. In the first place, the use of this kind of shaft was restricted to cases where keys were awkward or difficult to arrange, but the results proved so satisfactory that in the modern Lanchester car this system of connecting shafts and rotating parts has been adopted almost exclusively for all cases where there was any reasonable gain from having the shaft and the rotating parts so firmly connected, and the system has also been adopted by several other British motor car firms. It would appear, on first sight, that this kind of joint would be rather expensive, but it is claimed that the shafts and the corresponding holes can be produced comparatively cheaply. The slots are cut to the necessary depth on a milling machine, with ordinary milling cutters, and the corresponding female part is cut with a series of broaches. The first cost of the broaches is, of course, rather high, but the amount of work they will perform before worn out is so considerable that the unit cost per each detail finished is very small. The actual fit of the parts takes place on the external diameter of the shaft. The grooves are so milled that they will provide for as close a fit as possible on their sides, but a small clearance is allowed in the bottom of the grooves.—Machinery.

TIGHTENING BRASSES.

AN automatic device for connecting-rod brasses has recently been brought out by Messrs. Tangyes, Ltd., Smethwick, England. This device is shown in the accompanying cut, which is taken from the Mechanical Engineer. The bearing brasses, instead of being fixed in the usual manner, are given freedom to rotate, when too loose, under the friction of the crank-shaft, and this rotation of the brasses is utilized to effect the tightening of the screws *A* in the connecting-rod end and its cap. On the outside circular surface of the bearing brasses a worm thread is cut as shown, and small worm-wheels are arranged in recesses in the cap and connecting-rod end. The holes through these worm-wheels are threaded right- and left-hand to engage with the tightening bolts *A* as shown. By this arrangement it is evident that if the brasses revolve slightly, they will cause a slight motion of the small worm-wheels, and this in turn will tighten up the cap of the connecting-rod against the end, by means of the right- and left-hand threads in the small worm-wheels. Should the bearing brasses be loose enough so that the friction between the crankshaft and the brasses has a tendency to effect a rotation of the brasses, the pressure between the head and cap of the connecting-rod being insufficient to hold the brasses in place, a rotary motion of the brasses will take place and the worm-wheels will be rotated in the proper direction for drawing the screws inward, thereby tightening up the cap. When the pressure of the cap is sufficient to prevent the rotary motion of the brasses, these will remain stationary, and the crank-shaft will revolve as usual in its bearing. It will be seen that the bearing is thus automatically tightened whenever it becomes loose, and accident from the unfastening of the bearing is rendered impossible.

Fluid Steam Glue.—Over 50 parts of Cologne glue pour 50 parts of warm (not hot) water, and allow it to steep overnight. The following day the steeped glue is melted and if it is still too thick a little water may be added. After this is done, add 2.5 to 3 parts of crude nitric acid, stir well, and pour the fluid glue into closely corked bottles.

ATMOSPHERIC ELECTRICITY.

ITS DANGERS FOR THE BALLOONIST.

VARIOUS conjectures have been made as to the cause of the destruction of Count Zeppelin's airship. One very plausible explanation ascribes the catastrophe to the effect of atmospheric electricity. The principles involved may be described somewhat as follows:

Under normal conditions the earth behaves as a sphere charged with positive electricity, that is to say, any negatively charged body is repelled by the earth, while a positively charged body is attracted (Fig. 1). These forces of repulsion and attraction are very small, but are greater near the earth than farther away.

Now we may imagine a surface—extending through the air—such that the force upon a charged body is the same, and equal to some given value, at whatever

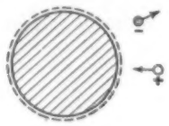


FIG. 1.

point upon that surface the body may be placed. Such a surface is termed an "equipotential surface." We may suppose a series of equipotential surfaces placed at various distances from the earth, each for a separate value of the force upon the charged body. As was stated above, the force is greater nearer the earth, and thus the series of surfaces will correspond with lower and lower potentials as we pass from the earth outward. In general outline they will be roughly parallel to the earth's surface, as shown in Fig. 2, but near irregularities in the earth's crust they are distorted somewhat, being crowded together over prominences, and spread apart over depressions as indicated in Fig. 3. Under normal atmospheric conditions, surfaces one meter apart correspond with a

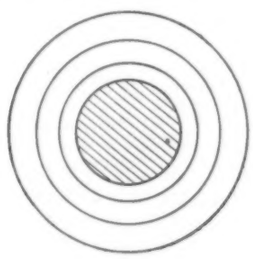


FIG. 2.

difference of potential of about 100 volts, 10 meters to 1,000 volts, and 100 meters to nearly 10,000 volts. These values fall from the earth outward, and are subject to continual changes under various circumstances.

We have so far considered the earth merely as an insulating medium, which transmits electrical forces, a dielectric, as it is called. This is not quite exact. As a matter of fact, the air itself has a true electric charge and a certain conductivity, by virtue of which a charged body may be gradually discharged therethrough. This conductivity is due to ions, small charged particles probably originating chiefly from radio-active substances.

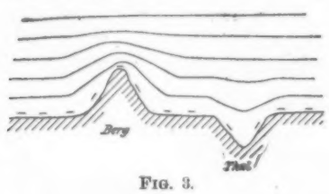


FIG. 3.

We may now pass on to consider the question: Under what circumstances can atmospheric electricity become a source of danger to the inflammable gas of a balloon?

The answer is, that a balloon will be in a critical condition whenever there is an abnormally rapid drop in potential in its neighborhood, while gas is escaping.

If there is a difference of potential of several thousand volts between two bodies, and if the latter are sufficiently close together, the difference of potential becomes equalized by the passage of a spark. Thus even with only 5,000 volts a small spark about 1 millimeter long may be produced. Such a spark may of course ignite any escaping gas.

On the other hand, if a body, such as the earth or a part of the balloon, has an abnormally large difference of potential with reference to the surrounding air, a silent discharge (St. Elmo's fire) may occur,

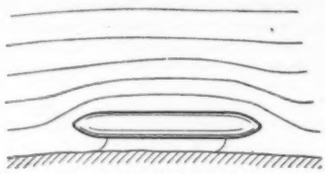


FIG. 4.

and it is not impossible that this also might endanger a balloon.

How a great drop in potential can be produced in the neighborhood of a balloon is best shown by the aid of the accompanying diagrams. Fig. 4 shows an airship before its ascent, connected to earth, and therefore practically at the same potential as the earth. Fig. 5 shows the balloon in the second position, some distance above ground. The cover of the balloon is still at the potential of the earth, and the equipotential surfaces are arranged as if the balloon were still

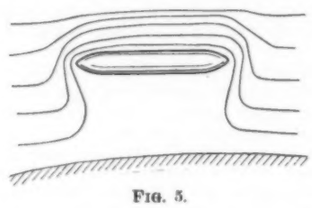


FIG. 5.

earthed, and are closely crowded above. But the ions in the air gradually tend to give the balloon a positive charge. As soon as its charge has reached a certain positive potential, the corresponding equipotential surface follows its contour, while the surfaces of lower potential have been pushed down below the balloon. (Figs. 5, 6, and 7.) Finally the balloon comes into electrical equilibrium with its surroundings. (Fig. 8.) It now has the least possible potential difference relative to its surroundings—so long as

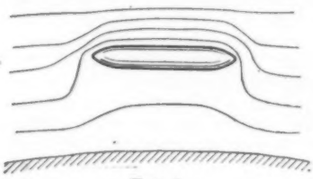


FIG. 6.

it neither rises nor descends. If it approaches the earth again, the inverse process takes place—it drags down with it the equipotential surfaces, crowding them together below. (Fig. 9.) A very considerable difference of potential between the balloon and the ground is thus produced. This difference will be the greater, the higher the balloon had previously risen. On making connection with the earth, a spark will pass.

Prof. Pfaundler has pointed out a contingency which

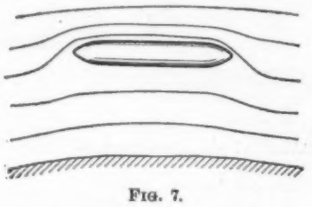


FIG. 7.

may very well have occurred at the time of the destruction of Count Zeppelin's airship. The Zeppelin airship had a metal framework, so that electricity could readily change its distribution upon it. The airship therefore behaved toward the earth like a conductor in the proximity of a charged body. It becomes charged "by induction." Positive electricity is "bound" upon the face turned toward the earth, while negative electricity is repelled to the parts situated farthest away from the earth. The tension thus produced is small if the balloon is horizontal, but may become quite large if the balloon rears up on end. Fig. 10 shows how the equipotential surfaces are distorted in such case. If the lower end of the balloon is not earthed by means of a well-conducting chain, a spark will be very apt to pass, causing an explosion if there is any escape of gas from the balloon.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

PRODUCTION OF TUNGSTEN.

THE principal tungsten minerals are wolframite, a tungstate of iron and manganese, and scheelite, a tungstate of calcium. Both minerals, like tin ores, occur as a rule in quartz veins cutting rocks containing much silica, such as granite and rhyolite. The deposits are usually pockety; that is, the ores occur in

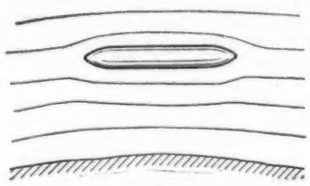


FIG. 8.

lenticular masses or shoots in veins. Those occurring at the surface are often quickly and easily mined, and it may then require all the profits made from the first exposed ore body to locate another one. In New Mexico, hubnerite and a small amount of scheelite occur with pyrite and lead minerals in a vein cutting limestone; and at Nome, Alaska, scheelite is found in the gold placers in a region of schists several miles from the nearest granite outcrops.

The greater part of the American tungsten product in 1907 came from the mines in Boulder County, Col., which reported an output of 1,146 tons of wolframite valued at $573,642.74. In California, which was the second State in order of production, the output was in the form of scheelite, as was also most of that from Montana. The total scheelite reported was 414 short

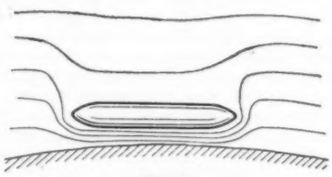


FIG. 9.

tons. Small amounts of tungsten ores were also produced in Washington, Nevada, Arizona and New Mexico.

As a result of the increased demand for electrical purposes, the output of the United States was increased from a total of 928 short tons of concentrates carrying 60 per cent of tungsten trioxide in 1906 to 1,640 short tons in 1907, while the value rose from $348,867 in the earlier to $890,048 in the latter year.

In other countries besides the United States the production of tungsten was notably increased during 1907. The output of Australia (including Tasmania), amounting to 1,643 tons, was, however, the only one that exceeded that of this country. Reports of production

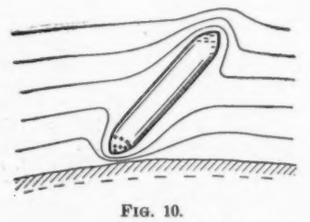


FIG. 10.

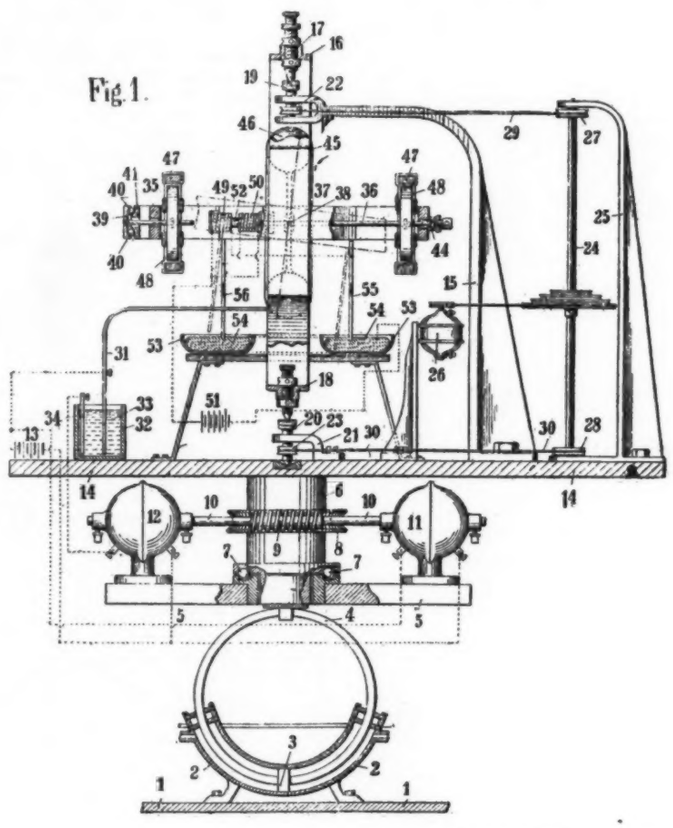
from South Africa, New South Wales, and the northern territory of Australia show marked increases.

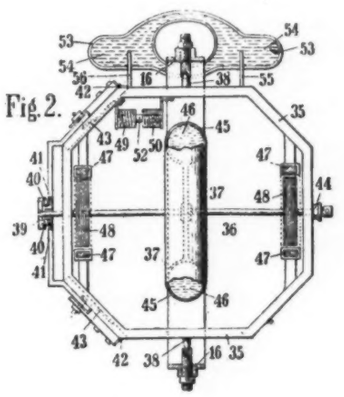
Decomposition of Water Vapor by Electric Sparks.—It has been suggested that the decomposition of water vapor in the case of thunderstorms may explain certain phenomena in those storms. Messrs. A. Holt and E. Hopkinson conclude from their experiments "that when electric sparks pass through water vapor or carbon dioxide the separation and arrangement of the decomposition products is not an electric phenomenon but results from gaseous diffusion. The hypothesis of electrolysis in liquids is therefore inapplicable."—Phil. Mag.

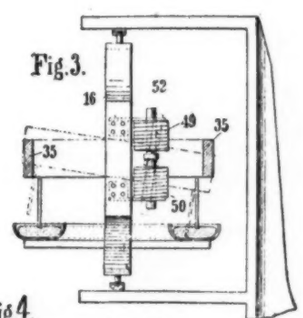
RECENT DEVELOPMENT IN GYROSCOPE DESIGN.

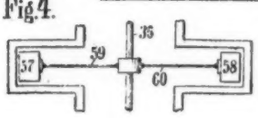
A NEW FORM FOR ENGINEERING USE.

WHETHER as a toy, a scientific instrument, or an object of practical utility, says the English Mechanic and World of Science, the gyroscope is of great interest. It seems rather more than likely that the gyroscope will play an increasing part in the construction of ships and railways, for in both these branches of engineering the practical utility of the gyroscope has been amply demonstrated by recent experiments. There are, of course, great drawbacks to the use of the gyroscope for mono-railways, not least of which is the danger of stoppage, and consequent downfall of the train of which it forms part. Many important developments, however, have taken place quite recently which will undoubtedly render the gyroscope a more practical piece of apparatus for modern utilitarian purposes. As an illustration of these developments, we here describe and illustrate a gyroscope invented by Prof. Narciss Ach, of Berlin, which has for its object a means of securing the invariability of the axis of rotation of the gyroscope, no matter what arbitrary movements may take place in the carrier of the gyroscope. Furthermore, the invention comprises means for securing an invariable position of the axis of rotation of the spinning body and of the rotatable frames forming support for same with relation to their carrier, in spite of any rotations of the support of such gyroscope carrier.









THE ACH IMPROVED GYROSCOPE.

In the accompanying illustrations, Fig. 1 is a vertical sectional view of the gyroscope.

Fig. 2 is a plan of the rotatable frame carrying the axle of the spinning body of the gyroscope.

Fig. 3 is a detail view, showing a modified device for securing an invariable inclination of the revoluble axle of the spinning body.

Fig. 4 is a detail view of a modified form of connection between the spinning body and carrying-shaft.

In Fig. 1, the part figured 1 represents the platform of a ship or some other object on which it is intended to use the gyroscope; 2 is a double-acting pump forming a curved tube, and containing a piston, 3, carrying a ring-shaped rod, 4, firmly connected to a plate, 5; 6 is a pillar mounted on the plate 5 by a ball-bearing, 7, and carrying a worm-wheel, 8; 9 is a worm meshing with said worm-wheel, and mounted on an axle, 10, which forms the common axle of two electro-motors, 11, 12; 13 is a source of electric power. The electro-motors 11, 12, are included in the current-circuit of such electric source in such a manner that the two motors tend to rotate the axle, 10, in opposite directions. On the pillar 6 is mounted a platform, 14, carrying a column, 15; 16 is a rotatable frame mounted by pins, 17, 18, on bearings, 19, 20. The bearing 19 is revolubly mounted in the column 15, and the bearing 20 is revolubly mounted in a bracket, 21. The bearings 19, 20 are provided with pulleys, 22, 23, respectively; 24 is an axle mounted in a bracket, 25, of the platform 14, and driven by a motor, 26, which is likewise mounted on the platform 14. Mounted on the axle 24 are pulleys, 27, 28, which are connected with pulleys 22, 23, by cords, 29, 30, respectively, said cords communicating rotation in opposite directions to said pulleys 22, 23, and bearings 19, 20; 31 is a pole-piece rigidly connected with the frame 16, and immersed in a receptacle, 32, containing a fluid, 33, forming a resistance included in the electric-current circuit containing the electro-motor 12; 34 is a second pole-piece, also immersed in fluid-resistance 33 opposite the pole-piece 31, and rigidly mounted, whereas the pole-piece 31 is adapted to follow the movements of frame 16. The current-conductors, including the said electro-motors 11, 12, and the fluid-resistance 33, are clearly indicated in Figs. 1 and 2; 35 is a frame rotatably mounted in the frame 16, and carrying the axle, 36, of the spinning body, 37. The axis of rotation of frame 35 in frame 15 is indicated by the numeral 38.

The axle of the spinning body 37 is provided at one end with a disk, 39, having a ball-bearing, 40; 41 are supporting pieces for the balls 40, which are connected by hinges, 42, with the frame 35; 43 are springs mounted on the frame 35, and having a tendency to raise the supporting pieces 41. The axle 36 of the spinning body terminates at the end opposite the plate, 39, in a point, said point running in a bearing, 44, carried by the frame, 35, and adjustable in axial direction.

The spinning body 37 is provided with a heavy rim, 45, forming a hollow ring, or a ring provided with a number of cavities symmetrically arranged all around said ring. The cavity, or the several cavities, of the ring 45 are filled with a heavy material of fluid, granular, or pulverulent nature—for instance, mercury or metal filings. The filling material of the cavities of ring 45 is indicated on the drawing with the numeral 46.

Firmly cemented with frame 35 are bodies, 47, provided with suitable coils, connected to a suitable source of electric currents of more than one phase. The numerals 48 designate rotatable inductors mounted on the axle 36 of the spinning body 37. The bodies 47, which may be called current-inducing bodies, and the bodies 48, which may be called current-induced bodies, form together electro-motors for currents of more than one phase. The inducing bodies 47 encircle the induced bodies 48, as is clearly shown in the illustrations; 49 and 50 are two coils carried by frame 35, and included in the circuit of a source of electric power, 51. The connections between said two coils, 49, 50, and the poles of the source of electric power, 51, are clearly shown on the drawing; 52 is an iron core shiftably mounted within the coils 49 and 50, and adapted to be moved toward one side or the other, depending on the kind of energizing of the coils 49 and 50; 53 is a ring-shaped vessel mounted on plate 14, and filled with mercury, 54; 55 and 56 are metallic rods connected to frame 35, and forming part of the current-circuits which include coils 49 and 50. The one pole of the source of electric power 51 is connected to the mercury filling 54 of the ring-shaped vessel 53, so that energizing of coils 49 and 50 only takes place when the corresponding circuits are closed by immersing of rods 55 or 56 into the mercury filling 54. The circuit connections are arranged in such a manner that the current flows through coils 49 and 50 in opposite directions.

In Fig. 3 a modification of the last-named device is shown, in which the coils 49 and 50 are not fixed to frame 35, but to frame 16, whereas the iron core 52 is fixed to frame 35 in substantially vertical position. The current connections may be identical with those illustrated in Fig. 1, and are therefore not shown in Fig. 3.

In the modification of the connection of the spinning body with the carrying axle shown in Fig. 4, heavy bodies, 57, 58, are connected to the revoluble axle, which in this case is again designated with the numeral 36, as in the other figures, by wires 59 and 60. The wires 59 and 60 prevent the flying away of the heavy bodies 57, 58 on rotation of the axle 36, and form a movable connection, allowing self-adjustment of the rotatable mass, so as to secure permanent symmetrical distribution of the mass in the same way as in the case where the spinning body is provided with cavities containing mercury or other suitable heavy material in fluid or granular condition.

Of course, the spinning body may also, in the case of providing cavities with mercury or other filling

material, have other forms than that of a hollow ring, although the form of a hollow ring has till now given the best results.

The operation of this gyroscope may be described as follows:

Assuming that the platform 1 is the platform of a ship, and the ship is moving on the sea, then the waves of the sea will cause the platform of the ship to continuously change its inclination toward the horizontal plane. If now the device is placed on the platform of the ship in such manner that the cylinder of the double-acting pump 2 is in vertical direction to the longitudinal axis of the ship, then the ring 4 of the pump will be moved in such a manner that the rolling movement of the ship is compensated so that the plate 5, in a direction parallel to ring 4, remains always horizontal. In the embodiment shown in the illustration only means are provided for compensating the variable inclinations of the platform of the ship toward the horizontal plane in one single direction—say, in the direction perpendicular to the longitudinal axis of the ship. Of course, it would be possible to provide also means for taking up the variable inclinations of the platform of the ship with relation to the horizontal plane in every other direction. This could, for instance, be done by combining the double-acting pump represented in the illustration with a second double-acting pump, having a ring-shaped piston-rod, lying in a plane perpendicular to the plane of the ring 4 represented in the illustration, such double-acting pump also controlled in a known manner in such a way that a plate carried by the ring-shaped piston-rod remains horizontally in the plane of the piston-ring.

The effect of a device like the double-acting pump 2 is this: that the plate 5 is rigidly held in horizontal position, although the platform 1 is rolling, and that the horizontal position is not altered even if a pressure asymmetrical to the point in which the plate is supported by ring 4 is exerted on the surface of the plate—for instance, at the point of the electric source 13. This is an essential difference between the kind of supporting of the gyroscope used in connection with the invention and the supporting of the gyroscope by means of a system suspended after the manner of Cardan.

If now the ship runs continuously in one definite direction, the parts of the gyroscope system will remain in their position with relation to the plate 5. However, if the ship alters the direction of its course, this would produce a tendency to deviate the axis of rotation of the spinning body by means of the several members connecting the platform 1 of the ship with the said axis of rotation of the spinning body. The spinning body, which all this time is rotating with high velocity, has a tendency to retain its original direction of axis of rotation. Now, the tendency of the members connecting the platform 1 of the ship with the axis of rotation of the spinning body to deviate said axis is overcome by the electrical means for adjusting the position of plate 14 with relation to plate 5—namely, these adjusting means operate in such a manner that on turning of plate 14 with relation to the plane of frame 16, which is substantially kept invariable by the rotating spinning body, the fluid-resistance included in the current of motor 12 is altered. The alteration of the resistance in the current of motor 12 influences the power of said motor in such a manner that the axle 10 of the two motors 11, 12, is rotated till the resistance in said current of the motor 12 has attained again the value of the original position of the parts. The rotation of the axle 10 produces a rotation of the pillar 6 with plate 14. This rotation of the plate 14 now produces on frame 16 substantially the same rotating tendency as the tendency of the displacement of parts produced by the alteration of the direction of the course of the ship. In this way the effect of the alteration of the course of the ship on the direction of the axis of rotation of the spinning body is substantially excluded.

It is important for the purpose in question that the means for adjustment in a horizontal direction are in direct operative connection with the support 14 of the gyroscope, and not with one or several gimbals of the gyroscope. Herein consists an essential difference between the device of this invention and previously known devices, in which the invariable position of one gimbal of a gyroscope is obtained by rotation of another gimbal.

For further correcting the influence of the varying direction of the course of the ship, adjusting means similar to those described and controlled by frame 35 could be used. The effect would also be essentially the same if, instead of frame 16, frame 35 would be used for controlling the adjusting means, because the displacement of plate 14 with relation to frame 16 causes a variation of the inclination of the revoluble axle 36 of the spinning body toward the horizontal plane 14.

Besides the alteration of the direction of the course of the ship, the invariability of the direction of the axis of rotation of the spinning body is disturbed by the friction of said axis in its bearings, and by the friction of the rotatable frames 16 and 35 in their bearings. As a means for overcoming this friction, rotatable bearings 19 and 20 are shown for the pins 17 and 18 carrying frame 16. Of course, also the bearings for frame 35 and for the revoluble axle 36 of the spinning body could be made, and preferably are made, revoluble. It is known that the influence of the friction is much more considerable if an object is put into movement from the situation of rest. Therefore, the influence of friction is diminished if the bearings of a rotatable body are permanently rotated, so that there exists no friction resulting from the starting of the rotatable object. The friction-diminishing effect is the completest possible if co-operating bearings—that is to say, bearings belonging to one single axle—are rotated in opposite directions, or if the same are only oscillated, so that the influence of friction exerted by the oscillation in one direction is compensated by the influence exerted by the oscillation in the opposite direction.

The influence of friction must be considered also in so far as it is caused by the weight of the rotating body resting in its bearings.

It is known to those skilled in the art that the spinning body is practically a body of considerable weight. Now, it is an essential point in a gyroscope that the rotating masses are arranged symmetrically to the axes of rotation. However, the influence of gravity cannot be excluded by merely distributing the mass of the rotating elements symmetrically to the axes of rotation if the axes of rotation do not remain in invariable position. Assuming that the mass connected to the axle 36 of the spinning body is arranged symmetrically to such axes, and to the axis 38 of frame 35, so that the bearings of the axle 36 are free from pressure in axial direction as long as the axle 36 remains in horizontal position, then pressure will be exerted on the bearings of said axle 36 if frame 35 is rotated about the axis 38. The bearing of the axle 36 in that part of the frame 35 which is inclined toward plate 14 must sustain pressure in the direction of the axle 36 resulting from the influence of gravity. In order to secure equal pressure on both bearings of the revoluble axle of the spinning body, the upper bearing is formed by the spring-actuated parts 41 connected to frame 35. The springs 43 take up one part of the weight of the spinning body and of its axle in a position inclined toward the horizontal plane. In this way the disturbing influence of the inclination of the revoluble axle of the spinning body toward the horizontal plane is diminished or entirely eliminated.

If an alteration of the inclination of the revoluble axle of the spinning body toward the horizontal plane takes place, the iron core 52 immediately readjusts the carrying-frame 35 of said axle—namely, under normal conditions the metallic rods 55 and 56 connected to frame 35 are immersed at the same time into the mercury filling 54 of the receptacle 53. Therefore, under normal conditions the current circuits of both the coils 49 and 50 are closed, securing an invariable position of the iron core 52. If, however, by some external influence, the frame 35 which carries the axle 36 of the spinning body alters its inclination toward the horizontal plane, then the one rod—say, 55—is immersed deeper into the mercury, the level of which always remains in a horizontal plane, whereas the second rod—say, 56—is elevated above the level of the mercury 54 so that the current-circuit through the one coil—say, 49—remains closed, whereas the current-circuit through the other coil—say, 50—is interrupted. The consequence of such interrupting of the current circuit of the one coil is a shifting of the iron core 52 in such a direction that the weight of the frame 35 on that side of the axle 38 which had been elevated is increased, thus producing a tendency to depress the elevated part of the frame 35 and to bring it back to its normal position in which the two rods 55 and 56 are immersed at the same time into the mercury 54.

The same effect would be obtained if the coils were not fixed to frame 35, and the iron core shiftable within the cores; but if, instead, the coils would be fixed to frame 16 and the core in substantially vertical position fixed to frame 35. In this instance the tendency of the coils to shift the iron core would result in a pull on frame 35.

The rotation of the spinning body which forms the essential condition for the practical use of a gyroscope is effected by two electro-motors for currents with more than one phase comprising the inducing bodies 47 firmly mounted on the frame 35 and the induced bodies 48 mounted on the axle 36. It has been found that the use of current-induced bodies mounted on the axle 36 and being separated from the spinning body 37 is of high practical value if such induced bodies form part of an electro-motor for currents with more than one phase, especially if the induced bodies 48 are encircled by the inducing bodies 47.

The gyroscope described above is provided with a number of improvements adapted to diminish the disturbing influences of the movement of a ship or other carrier of the gyroscope. It is to be understood that it is not necessary that all the said improvements are used in combination with each other, and that numerous changes may be made with relation to the details of construction. For instance, instead of the plate 5 rigidly held horizontally by the ring 4 of the double-acting pump 2, other power-actuated means may be used for holding the plate 5 rigidly in horizontal position—for instance, a rotatable frame which is provided with a power-actuated spinning body may be used to carry plate 5, the revoluble axle of the same being mounted in such rotatable frame, so that the gyroscope which is intended to be used for measuring and similar purposes, such as determination of the course of a ship instead of a magnetic compass, is carried by the inner gimbal of a second gyroscope. Furthermore, other means for controlling the operation of electro-motors 11, 12, different from the fluid-resistance 33, may be used, as is obvious for those skilled in the art. Furthermore, the means for taking up the weight of the spinning body on alteration of the inclination of the axle of the same may be provided intermediate the bearings for the axle.

DO THE RADIO-ACTIVE GASES (EMANATIONS) BELONG TO THE ARGON SERIES?

IN introducing his paper, entitled "Do the Radio-active Gases (Emanations) Belong to the Argon Series?" Sir William Ramsay, K.C.B., F.R.S., remarked to the British Association that the properties of several elements had been predicted on spectroscopic evidence and from a study of the periodic tables of atomic weights, thallium (by Crookes), gallium (by Lecoq de Boisbaudran), and indium (by Winkler), and he made suggestions as to the positions of the emanations in the tables. The paper was thus rather one for the Chemical Section. The residues of the fractionation of 120 tons of liquid air obtained from France, he stated, had been examined in the chemical laboratory of University College by Prof. Moore. Nitrogen and oxygen having been removed (the latter finally by phosphorus), argon, krypton, neon, and xenon had remained, and by methodical fractionation the 300 cubic centimeters of xenon had ultimately been reduced to 0.3 cubic centimeter. This gas appeared spectroscopically as pure xenon; if it had contained 1 per cent. of a denser gas, that gas would have been detected, and the air could not contain more than 1-25th billionth of any gas denser than xenon; if such an element existed at all, it should be gaseous. The atomic weights of the inert gases were: Helium 4, neon 20, argon 40, krypton 83, xenon 130. Pointing then to Lothar Meyer's arrangement of the atomic weights in a periodic table, the author directed attention to the fact that the hypothetical elements of several of the vertical columns of that table were either all unknown, or that there were many vacancies. Some of these he proceeded to fill up by the emanations. Thus, in the series just mentioned there were vacancies for the atomic weights 172, 216, and 262; the last column should contain elements of atomic weights 252, 259, 261, 267, and 271—all unknown—and he suggested, from determination of the density of the emanations (based on diffusion tests), and from other arguments, that the emanations of thorium, radium, and actinium had the atomic weights 178, 216, and 262. Thorium itself (232) was more likely to come down to 172 than go up to 262.

Prof. Rutherford, opening the discussion, remarked that we had pretty good grounds to class the emanations of thorium and radium with the inert gases. As to atomic weights, he admired Prof. Ramsay's respect for the periodic table, but he could not go so far. He (Prof. Rutherford) had found that the α particle was a helium atom; the atomic weight of uranium was 238.5; by splitting off 2 α particles uranium passed into Bolton's ionium (atomic weight 230.5); then came by further splitting off of α particles, radium 226.5, radium A 222, radium B and C, and ultimately lead 206.5. It was noteworthy that lead, with which the radio-active elements were associated, was at the end of the series. But all this was far from being proved; the periodic law was elastic, and we could not speak definitely before we had locked radium up for many years. According to Bronson, thorium did not throw off α particles on the lines of radium; actinium belonged to a side branch; he might know more about that in another year. Sir Oliver Lodge agreed with Prof. Rutherford, but pointed out that all the elements with high atomic weights seemed to be unstable. Mr. T. Royds said that actinium seemed to be lighter than thorium (not heavier), and he agreed with Rutherford as to the unreliability of difficult diffusion experiments to fix the position of an element. Sir W. Ramsay answered that his reply would take far too long a time, and the subject was not yet ripe for discussion; but Rutherford had altogether left out neon. To this Prof. Rutherford retorted that he was not convinced of the production of neon from the emanation. Prof. Lees, who occupied the chair, having in vain called upon Prof. J. J. Thomson, Larmor, and Armstrong, remarked that the skillful treatment of the residues was very interesting.

THE MAKING OF DIAMONDS.

WHAT HAS BEEN DONE BY THE MAKER OF ARTIFICIAL GEMS.

THE diamond has a most eventful history. No single country claims to be its birthplace, nor is it always found under the same conditions. Its home may be in India or South America, Australia or South Africa, Russian Lapland or the plains of Arizona. It has been discovered among the pebbles in a stream, imbedded in the bowlders of an igneous rock, in gold-washings, in meteoric iron, and (if we can believe Sindbad the Sailor) in beefsteaks brought up from inaccessible valleys by eagles and vultures. It varies in color no less than in weight. It may be white (or what naturalists call colorless), with an occasional tinge of yellow, red, orange, green, and sometimes black.

Ever since the old Greeks called it *adamas* (the invincible), the diamond has exercised a peculiar fascination. To discover its composition hundreds of gems have been destroyed. Composed of only one element, and that the commonest in Nature, it stands alone among precious stones and constitutes a class by itself. Many strange tales have gathered round its quest. We read of diamond hunters, diamond smugglers, diamond thieves, and diamond makers. It has been counterfeited in paste and actually produced by chemical art. In fact, there is and always has been a diamond cult.

How does Nature make the diamond? That is Nature's secret, which nobody knows. Various theories, ranging from the suggestion of a vegetable process to the crystallization of carbon at great depths under the earth's surface, have been propounded. Sir David Brewster maintained that the diamond was fossilized resin deposited from the sap of a plant, just as a peculiar variety of flint is found in the branches of the bamboo. This view was accepted by Jameson, the famous mineralogist of his day; it was also favored by Petzholdt, who based his conclusion upon an examination of the ash which is sometimes left after a diamond is burned. Others have maintained that the diamond is made from carbon which has crystallized after being in a liquid condition. Intense heat and pressure, it is said, have liquefied carbonic acid, and as the liquid cooled the formation of the diamond began. Others, again, have maintained that the diamond has been crystallized from molten iron. A remarkable discovery of sixteen years ago lends support to this view. It was supposed that the plain of Arizona contained a vein of iron from the fact that many pieces of the metal, some of them of considerable weight, were found lying on its surface. The iron was pronounced to be meteoric, and when an attempt was made to cut one of the pieces it was found to contain certain hard grains which resisted cutting. These grains were declared to be diamonds. The declaration made such an impression that one of our distinguished scientists suggested that the diamonds which have been found under isolated conditions in sands or gravels on the surface of the ground may have had a meteoric origin. It is well known that acids will dissolve iron and leave a diamond unaffected. The atmosphere will do the same if the iron be exposed to it long enough. Had the Arizona iron been left exposed the diamonds, in the course of time, would have been liberated, and be found distributed over the soil. Hence the conjecture that single diamonds picked up occasionally on superficial deposits, though regarded as minerals, may have had an extra-terrestrial origin.

After all, there is evidently no single mode of origin common to all diamonds. The latest conclusion is that, in different deposits, the gem has been made in different ways. When it occurs in a crystalline igneous rock—as in India, Lapland, and South Africa—it is supposed that it was during the cooling and subsequent solidifying of the rock, after passing through a melted condition caused by volcanic agencies, that the diamond crystallized, its carbon being either present as part of the rock or derived from some carbonaceous source outside of it. When, on the other hand, the diamond occurs, as in Brazil, with crystals of quartz, it has evidently been made in a different way. The scientific name of quartz is itacolumite; it belongs to the group of rocks known as metamorphic. This means that the rock was originally deposited from a watery solution, and probably even at an ordinary temperature. In Brazil the earlier diamond-hunters searched for their treasure below the beds of rivers, digging through the upper clay to the quartz-vein beneath and finding the gem there. In this case the conjecture is that the diamond was made in the same way as the quartz in which it is found. This, however, brings us no further than the point at which we started. Nothing is known regarding the character of the solution by which the diamond is deposited in its matrix, and so the natural origin of the gem is still to a great extent shrouded in mystery.

But though the secret has been so well preserved, the composition of the diamond itself has long been known. The ancients had no suspicion of the true nature of the element of which the diamond is made. They fancied it was a kind of crystal. Even as late as the middle of the eighteenth century, an authority on physics defined its composition as "the purest and finest earth, the most ethereal fire, and the most limpid water." Modern chemistry has changed all that. The most refined experiments of Lavoisier in France and of Davy in England have proved that the diamond is pure carbon in a crystalline state. This conclusion, however, was not accepted without question. It was hard to believe that the precious gem and the common element carbon were one and the same thing. Accordingly Guyton de Morveau made further experiments with a view to confirming or rejecting the conclusions of Lavoisier and Davy. Morveau's method was so different from the usual procedure that we cannot help admiring its boldness and ingenuity. It is well known that a piece of soft iron, when heated with charcoal or carbon, absorbs some of the charcoal and becomes steel. Morveau substituted diamond for charcoal, and he converted a fragment of soft iron into steel identical in every respect with the steel produced by the usual method. The question of the composition of the diamond was thus finally determined.

No other gem consists of one, and only one, element, and this apparent simplicity has not only attracted artificial production, but has also been the insuperable barrier which has hindered success. Artificial diamonds have certainly been made, but on such a small scale that they have been practically useless. By the term artificial we do not mean a glass or paste imitation, but the real substance, so made by chemical art that the product is the same in every respect as that made by Nature. Different workers have employed different methods, and with varying success. In 1853 the method of Despretz consisted of depositing carbon by the disruptive action of the electric spark in a large vacuum tube. The carbon was deposited on platinum wires, and the deposit, when viewed under the microscope, had certain remarkable features. At the ends of the wires some points were seen which experts pronounced to be octahedral crystals—the form in which nature gives us the diamond. In color they were black and white. Tested upon hard stones, the substance polished a ruby. As diamond is the only substance that polishes ruby, the deposit was pronounced to be the powder of the diamond.

The next notable attempt was made in the direction of dissolving carbon in a liquid. Sugar or salt dissolved in a liquid leaves the crystals of sugar or salt behind when the liquid has evaporated. In the same way, if we could dissolve carbon, either as charcoal or lamp-black, and by the evaporation of the liquid allow the dissolved carbon to separate out, it would probably crystallize in the lustrous form of diamond. In 1880 J. B. Hannay, a Glasgow chemist, conducted a series of valuable investigations on the solubility of solids in gases, and claimed the discovery of a solvent for carbon. He was the first to dissolve silica in a gas. He found that the metal lithium could separate the carbon from a hydro-carbon—that is, from a compound of hydrogen and carbon. He placed lithium and kerosene—the latter being the hydro-carbon—and some sperm oil in strong wrought iron sealed tubes, which were then exposed to enormous pressure and high temperature. Out of numerous experiments only a few had a measure of success, Hannay's difficulty being to get tubes strong enough to resist the heavy pressure and the intense heat. Though the sides of the tubes were 3½ inches thick, they exploded as if built of cardboard. Hannay expected that the carbon, separated by the lithium, would dissolve in the sperm oil, and that when the solution cooled the carbon would crystallize in the form of a diamond. The result was a crystalline mass. It was diamond, but in the form of a fine sand.

The next worker in the same field was the French chemist Moissan, whose researches on the distillation of metals have attained a world-wide fame. Moissan used molten iron as the solvent. He placed carbon in an iron cylinder, and put the cylinder in a bath of boiling iron in the electric furnace with its temperature of 3,500 deg. C. The cylinder, under these conditions, became soaked with carbon. The hot mass was then plunged into cold water. This solidified the molten iron. Molten iron, like water, expands as it solidifies. Moissan thus produced a strong solid crust which held the inner molten mass in its grip. As the inner mass cooled its expansion produced an enormous pressure. Under this pressure the dissolved carbon separated out in a crystallized form. The size of the crystals did not exceed one-fiftieth of an inch across, but they proved to be absolute diamonds by withstanding all the known tests. They were completely combustible in air, they yielded carbonic acid gas as the sole product of combustion, and possessed the hardness and refractive qualities of the natural gem.

More recently a method of artificial production has been devised by Friedlander. A piece of olivine—the glassy, translucent species of silica, of a light olive color—after being fused under the blowpipe, was stirred with a rod of soft carbon. On cooling, the silicate was found to contain a number of crystals which were even smaller than those obtained by Moissan. The crystals had the diamond or octahedral shape, they resisted acids, were refractive, burned in air, and scratched ruby.

The investigations of Moissan and Friedlander, apart altogether from the size of their artificial diamonds, are valuable in one respect. They afford a plausible theory as to nature's mode of working. Moissan helps to solve the mystery as regards the diamonds found in meteoric iron. Friedlander does the same with regard to those of South Africa—that these may have been formed by a molten silicate acting on a carbonaceous material. The problem, however, may be solved otherwise. It is quite possible that if Moissan's process dealt with a few pounds of iron instead of with a few ounces, subjected to greater pressure and higher temperature, the result would be larger diamonds. It is in this direction, judging from the conditions already known, that success seems to lie. A higher temperature than 3,500 deg. C. has just been produced. It has been accomplished by Sir Andrew Noble in exploding cordite in a closed chamber. A temperature of 5,200 deg. C. was reached, and a pressure of fifty tons to the square inch. The temperature melted carbon, and from the melted carbon diamonds were naturally expected. On analyzing the carbon in the explosion chamber, minute diamonds were found in it, proving that before crystallization the element had passed through a liquid condition. These results may be the forerunners of a greater achievement. The crystals already produced artificially, though inapplicable for ornament and having no commercial existence, may be the first fruits of the secret which Nature shall yet give up. And when she does, the chemist will not be surprised.—Chambers's Journal.

WHAT IS THE GOOD OF COMPARATIVE ANATOMY?

To understand our own bodies we have to explain them in terms of the structure of other animals, and many of our parts would be meaningless to us but for a knowledge of comparative anatomy. Our cankered veriform appendix is represented in some animals by a large and serviceable attachment of the digestive tract, which explains it as a degenerate organ and therefore necessarily variable. Deep between the hemispheres of the brain is a little sac about the size of a pea, the pineal gland, and comparison shows that this was once a third eye. Sometimes an opening persists on the side of the neck below the jaw; in such a case one of the embryonic neck clefts has remained open, and this in turn has relations to the gill slits of a fish. All the ground plan of our bodies, the muscle cylinder within the skin, next the bony scaffolding, innermost the peritoneal sack around the viscera, all such relations would remain a mystery did we study only the human body. But in the light of comparative anatomy and embryology we recognize them as necessary parts of our heritage. Medicine must stand upon a thorough knowledge of the structure and processes of the human body, and before it can treat disorders it must understand states of health and their origin. Comparative anatomists and embryologists, the great men Harvey, Wolff, Von Baer, Cuvier, Agassiz, Huxley, Cope, and Gegenbaur, such men have not only broadened the field of human thought, but have also furnished the understanding of the human organism. They were all pure scientists, they did not have in mind the care and cure of the human body. Yet we might say they accomplished more for a rational medicine than all the physicians before them. How unlikely the prophecy seemed that any direct advantage would come to mankind from the researches of Harvey, Wolff, and Von Baer on the development of the chick, from those of Cuvier and Agassiz on fossils, or from those of Huxley, Cope, and Gegenbaur on comparative anatomy. As the result of this change of thought we now see most medical schools prescribing biological courses, and choosing their professors of anatomy largely from the ranks of embryologists.—Popular Science Monthly.

CONCRETE PILES AND SLEEPERS.*

WHAT CONCRETE CAN DO IN DISPLACING WOOD.

BY ALEXANDER CRAWFORD CHENOWETH, LL.D.

THE proposed guarantee of bankers themselves of the securities they offer is by no means an ideal condition.

Reinforced concrete piles were first introduced in Europe about 1900. They were cast in forms with a square cross-section, and reinforced in the four corners with steel bars tied together every six inches of the length of the pile. These piles were driven by a hammer, using a driving cap with a cushion. They were limited in their length and diameter, lacking proper distribution of steel reinforcement. This same argument applies to piles constructed in place, since designed.

I have the honor of presenting a method of construction, using no forms, producing a reinforced concrete pile by simply rolling a sheet of concrete and metal netting into a solid cylinder, as illustrated in the accompanying cuts. Piles thus manufactured can be made in long lengths and a wide range of diameters.

The compressive value of concrete is many times greater than its tensile strength, while it is just the reverse of steel. In this construction the reinforcing members act independently, the concrete carrying the load action under a compression stress, while the steel reinforcement resists the tensile stress.

The cross-section of the pile is shown on page 329 in the drawing. *A* is a steel pipe or rod, *B* is a coiled sheet of wire netting, and *C* are longitudinal steel rods, placed near the periphery, equal distances apart, parallel to the longitudinal axis of the pile. The pipe or rod *A* forms the shaft or mandrel on which the pile is rolled or wound and the netting *B* and rods *C* constitute the reinforcement.

The apparatus for rolling the pile is shown by illustration. In this apparatus there is a traveling platform between which and the roller the pile is formed. The winding pipe or mandrel is set in line of the shaft of a large spur wheel. In operation the steel wire netting with the longitudinal rods attached is spread on the platform and covered with a layer of concrete. (See sketch *C*, on the next page.)

* Paper read before the New York Railroad Club.

One edge of the netting is attached to the edge of the platform, and the other edge to the winding pipe or mandrel. Thus arranged the winding mandrel is rotated and the netting and its covering of concrete are wound or coiled up as indicated in sketch *D*,

CHENOWETH REINFORCED CONCRETE PILE, JERSEY CITY. DRIVING A CONCRETE PILE 50 FEET LONG, 15 INCHES DIAMETER.

next page. At the same time, and as fast as the netting and concrete are coiled up, the platform *A* moves under the roll *B* and the roll itself rotates.

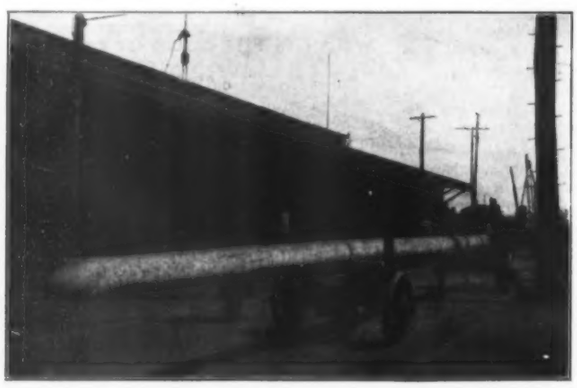
The forming cylinder or concrete is by this means kept under constant and heavy pressure between the platform and roller. To bind the roll of concrete, wires are wound around it at close intervals and tied. The wires are contained on spools arranged beneath the moving platform. These spools are spaced every six inches along the pile and fastened to the wire mesh, so that when the pile reaches the lower edge of the platform it can be revolved about the axis, causing the wire to be wound on the pile. In this manner the wire is passed around the pile a number of times and secured. At the driving end of the pile the spools are placed four inches apart for the first six feet of the pile and then six inches apart for the remainder of its length. The pile is removed from the machine by rolling on to a car, when it is transported to a platform where the point is formed, flushed up or smoothed, if desired, and allowed to remain until it hardens.

By this method piles of all lengths and diameters can be made. The diameters of the reinforcing rods have been determined for all lengths up to 61 feet; also the ratio of the diameter of the pile to the length of pile by actual experiments.

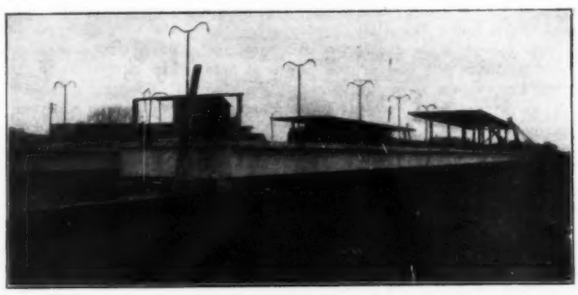
This form of reinforcing is well adapted to resist tensile strain due to eccentric loading. It may be called a hopped column, the properties of which have been well defined by Prof. W. Kendrie Hatt.

This pile is able to withstand rough treatment in handling and driving. Its bearing capacity is four times greater than that of a wooden pile. A pile 61 feet long, 13 inches in diameter, can be suspended in the middle, dropped from platform cars, rolled down an embankment, and driven in the hardest kind of material. It shows a remarkable degree of elasticity.

A pile 61 feet long and 13 inches in diameter was recently driven before a committee of experts, at a place known to be particularly difficult to penetrate. The material was mud and compact gravel. The pile was given some 400 blows with a hammer weighing 3,600 pounds, and driven until it refused, with ten blows with a drop of 20 feet, to move further. It was then decided to hammer it to destruction. The blows were continued with a brooming of the head. The pile was pulled up and examined and found in perfect condition. The head was broomed for twenty inches. The verdict was that the pile had withstood the severest test, far beyond the endurance of a wooden

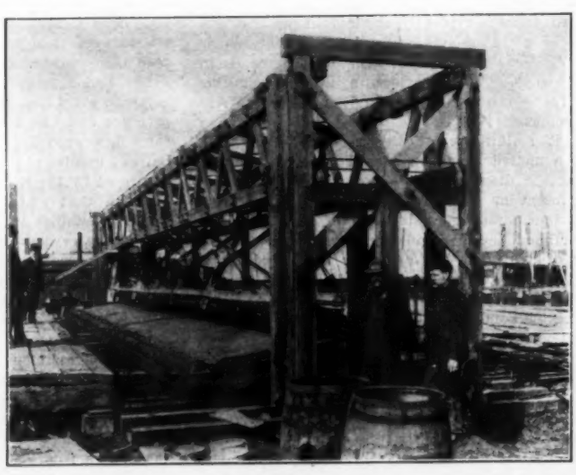


REINFORCED CONCRETE PILE 50 FEET LONG, SHOWING HOW PILE MAY BE HANDLED. WEIGHT OF PILE, 3 TONS.



PLATFORM, KINGS HIGHWAY STATION, BRIGHTON BEACH & CONEY ISLAND RAILROAD. CONCRETE PILES.

REINFORCED CONCRETE CROSS TIE, PHILADELPHIA RAPID TRANSIT. VIEW ON WALNUT STREET, PHILADELPHIA.



MACHINE FOR MANUFACTURING REINFORCED CONCRETE PILES 60 FEET LONG, 14 TO 16 INCHES IN DIAMETER.

REINFORCED CONCRETE AS A SUBSTITUTE FOR WOODEN PILES AND CROSS-TIES OR SLEEPERS.

pile, without failure. The penetration into the gravel was 8 feet, the pile having an area four times greater than a wooden pile.

The committee adjourned to make a land test. A place was selected where it was known to be a fill some 40 feet, consisting of old canal boats, crib work, and bowlders. A pile 45 feet long was selected and a hammer weighing 2,500 pounds was used. The pile with 170 blows moved until a timber obstruction was reached. After repeated blows it refused to move with a 20-foot drop. The committee decided that a timber obstruction was reached, and a heavier hammer, weighing 4,600 pounds, was called into service. The head of the pile was squared up, and with blows with the new hammer, 10-foot fall, the pile penetrated the obstruction and was driven to the surface without reaching rock, which was thought to be about 43 feet below. The treatment given this test was also decided to be more than a wooden pile could possibly stand.

Piles of this construction have been used in the foundation of the pumping and electrical power house of the Erie Railroad at Susquehanna, Pa., also in the station platforms of the Brooklyn Rapid Transit Railroad, Brighton Beach & Coney Island division, at Avenue A, Greenfield Avenue, Kings Highway, and Sheepshead Bay.

A driving cap (shown herewith) is used consisting of a cylinder of steel with a diaphragm midway between ends. This is placed on the pile with a coil of rope as a mat, below diaphragm, sawdust, and a wooden follower block.

The mixture used for concrete is one of cement, two of sand, and three of gravel. This proportion appears to give the best results.

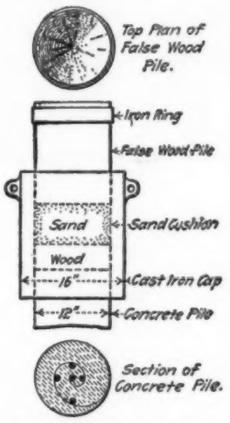
Concrete piles constructed in 1900 were driven in the foundation of coal pockets at Southampton, England. Recently it became necessary to shorten them after being exposed for eight years to salt water and tidal changes. They were found perfect, and the steel reinforcing members one-quarter of an inch below the surface were not corroded and were in good condition.

The reinforcing of concrete to resist impact suggested the same form of construction to be applied to a railroad cross-tie or sleeper. This selection has been well established by severe tests now being conducted on the Pennsylvania line west of Pittsburg, at the Scully yard, where the cross-ties have been in the track for two years. The Interborough Rapid Transit, New York city, has some in the west track at Dyckman Street station, which have been in place since July, 1905. The Philadelphia Rapid Transit have some ties on their Walnut Street surface road. They so far give satisfaction, having occasioned no complaint.

At the Scully yard, Mr. W. D. Wiggins, Esq., engineer of maintenance of way, in a report dated April 24, 1908, states: "Several of the ties have been damaged by derailed cars, but have not been broken."

Some explanation of the form of this tie, which is made in the same way as the pile before described, may not be out of place. The roll is placed in a form and squared by pressure and a mixture of sand and cement. The holes for the fastening device are made by steel pins being pressed through the tie by means of a template. They are exact. The pins are withdrawn before the tie hardens. The fastening device for fastening the rail is shown below. A small shell of galvanized steel coiled into a hollow frustum of a cone. Into the large end of the cone is inserted a spiral spring of proper pitch to mesh with threads of a ¾-inch commercial lag screw. The shell with spring is inserted in the conical hole at the bottom of the tie indicated on this page.

The lag screw is passed through a clip engaging the flange of the rail and screws into the spiral spring until the rail is tightly clamped to the tie. In practice a hard wooden block is placed below the rail.



SHOWING DRIVING CAP.

This deadens the shock. In the case of the Interborough Rapid Transit road, and also the Philadelphia Rapid Transit, the block has stood and shows no deterioration, although but one-half inch thick in the case of the first road mentioned.

The block used on the steam road at Scully had to be renewed, as the rail cut into the blocks in a very short time. I suggested a steel tie plate be placed on top of the block. The plates were ordered, not before some of the wooden blocks had been cut through, leaving the rail to pound upon the concrete tie. The effect was to damage the tie under the rail, which was observed on four of the ties, about 2 per cent. This Scully track deserves some notice. There was no indication of any track force ever having given it much attention, being used to transport freight and coal cars. Trains loaded with iron from Carnegie Iron Works moved over the line every five minutes, day and night. The rail was light; cross-ties were placed 22 inches from center to center; splice bars fastened to rail with four bolts, never tight; joints working loose, ballasted with culm and ashes. The lifetime of a wooden tie was from six months to eighteen months. This is where the test was given to this form of a reinforced concrete tie. They are still in the track. The fastening of the rail used was as described.

The lifetime of a wooden tie has been given as from six to eight years, due to decay largely and to crushing from heavy loads. Concrete ties would be indestructible and cost very little more than wooden ties, when manufactured by the railroads themselves.

In practice, concrete ties should be placed about 10 inches apart, with a wooden block under the rail. This wooden block in steam roads should have a steel plate on top, below the rail, to increase the bearing surface of the lower flange of rail. The rail should not be less than 100 pounds per yard. In electric or street roads, the steel plate can be omitted.

The report of the Board of Railroad Commissioners of the State of New York, for the year ending June 30, 1906, states:

Boston & Maine Road.—2,287 Miles of Track.

Renewals of cross ties	$712,644
Passenger cars, repairs to rolling stock	928,261
Repairs to freight cars	1,051,719
Repairs to work cars	46,276
Loss in damages	268,377
Injury to passengers	710,222
Clearing wrecks	48,222
Life of a cross-tie	eight years
Operating expenses	75 per cent of earnings

New York Central & Hudson River Railroad.—Total Miles of Track, 3,580.

Renewals of ties	$1,077,973
Repairs to passenger cars	1,571,315
Repairs to freight cars	5,485,317
Repairs to work cars	117,658
Lifetime of a tie	eight years
Operating expenses	73 per cent of earnings

New York, New Haven & Hartford Railroad.

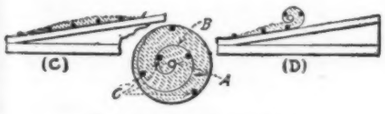
Renewals of ties	$700,589
Lifetime of a tie	six years

REBUILDING THE PARIS TELEPHONE SYSTEM.

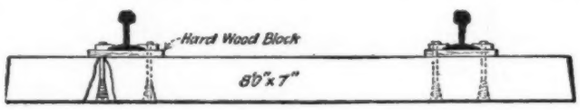
ACTIVE steps are being taken to repair the disaster caused by the Paris telephone fire which destroyed the Gutenberg or central exchange having connections with about 19,000 subscribers. After re-establishing the most important lines general partial relief has been afforded by connecting up a number of extra public telephone booths in the central district. A temporary shed to house the apparatus for the 19,000 subscribers is now being set up in the Rue de Gutenberg between the burned building and the central postoffice. Although somewhat narrow, this location is the best for the purpose, as the underground cables can be led into the temporary boards with a small amount of cable.

A set of small boards will be set up at once in the finished shed to accommodate the principal subscribers, and two multiple boards from different Paris constructors have been ordered for the general service. The work of installing the long-distance exchange in a private building near the present site is already begun. For one of the two permanent exchanges the gutted building will be reconstructed for a third multiple board. One of the multiple boards of the temporary shed finally will be placed in a new building, leaving the third board to be used as a standby. It is expected that the temporary exchange will be working within two or three months, while the remainder of the project will take perhaps ten months.

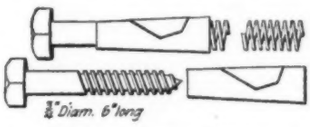
The material amount of the loss is estimated to be about $1,000,000, by far the greatest loss ever due to a telephone fire in Europe.—Western Electrician.



THE PILE CONSTRUCTION.

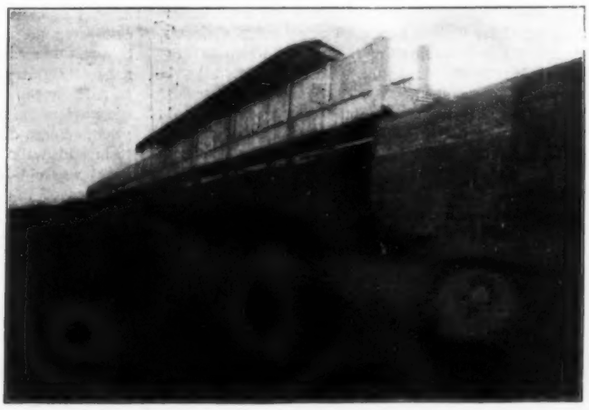


REINFORCED CONCRETE CROSS TIE.



FASTENING USED IN SECURING RAIL TO CONCRETE CROSS TIE.

REINFORCED CONCRETE CROSS TIES, INTERBOROUGH RAPID TRANSIT RAILROAD, DYCKMAN STREET STATION.



PLATFORM ON CONCRETE PILES, BRIGHTON BEACH & CONEY ISLAND RAILROAD, GREENFIELD AVENUE, BROOKLYN.

REINFORCED CONCRETE AS A SUBSTITUTE FOR WOODEN PILES AND CROSS-TIES OR SLEEPERS.

THE PENGUIN EGG.

THE STRANGE PRODUCT OF A GROUP OF LONELY ISLANDS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

DURING the past few years an increasing trade has been built up in South Africa in the sale of penguin eggs, the value of which as a comestible has become widely recognized, and to-day the industry has attained extensive proportions. The egg of this sea-fowl has excellent nourishing qualities, which combined with the fact that it is easily digestible renders it a suitable article of diet for invalids. Though the bird subsists on fish the flavor of the eggs is not widely dissimilar from that of the domestic hen, and in South Africa is much preferred to the latter. A curious feature in cooking is that the albumen does not become solidified and of an opaque whiteness as does that of the chicken's egg, but retains its jelly-like character and is of a pale blue color. In size the egg approximates that of the goose or terrapin. During the past few months consignments of these eggs have been exported to Great Britain, and although their characteristics are unfamiliar the easily digestible qualities of the edible have been quickly appreciated and the trade in the article is rapidly extending.

The eggs are obtained from the group of rocky islets off the southwestern coast of Cape Colony within easy reach of Cape Town, of which the islands of Dassen, Jutten, and Malagassen are the largest and most important. These islets, which do not aggregate more than about fifty acres in extent, are merely the abode of wild sea-fowl, among which the penguin overwhelmingly predominates, and owing to their barren nature are quite uninhabited with the exception of the rangers appointed by the South African government who reside thereon, since the islands are government property. Formerly they were merely exploited for their valuable and extensive guano deposits, the right to work which was awarded by tender by the government. To-day, although guano is still exported, penguin eggs constitute the most important product, and a strict surveillance is maintained in order to protect the birds and their eggs.

The low-lying coast portions of the islands constitute the haunts of these sea-fowl which abound in such prolific numbers that it is impossible to walk along the shore without coming into contact with them. The birds are remarkably tame and do not evince the slightest alarm at the approach of a stranger. Indeed it is difficult to make your way along the coast without jostling them, and as they make no attempt to move on one side to facilitate the visitor's progress they have to be pushed unceremoniously aside, an action which causes them to give vent to a savage snap. Such tameness is somewhat curious, since when castaways out scavenging for food are caught by unpropitious winds, currents, or stormy weather and, unable to make their return to their home, are cast up on the mainland, they exhibit extreme timidity, hurrying away to some refuge upon human approach.

So extensive are their numbers that the resident official's house has had to be encircled by a low wall about two feet in height to prevent the birds overrunning the dwelling. Owing to the absence of wings the birds are perforcedly compelled to keep to the low-lying shore line, where they fashion their primitive nests, consisting for the most part of mere holes in the sand, in which they deposit their eggs. At the same time they are very jealous of their territory and resent the intrusions of any other birds. Should an unfortunate wanderer alight on the shore such action is the signal for instant battle. The penguins viciously attack the interloper in force and compel him to beat a hurried retreat, or should he be exhausted he is straightway dispatched.

The islands are never visited except by the boats bringing stores for the rangers and the men engaged in the collection of the guano and the eggs, the government keeping the birds as free from outside disturbance as possible. The egg-collecting season extends through three months of the year, March, April, and May, and is carried out upon thoroughly comprehensive lines. The collectors wrap their legs in some stout material to secure protection against the sharp bills of the birds, who make vicious attacks while their nests are being robbed, while in their hands they carry a short club carrying an iron crook at the lower end.

The task of scouring the islands for eggs is carried out simultaneously, and the work is so arranged that the whole of the nests may be cleared in a single day. The men have to elbow their way among the birds who refuse to budge an inch. They cannot be frightened from their nests where they sit on their eggs in sullen indifference. To attempt to eject the bird with the hands would be to invite a savage snap, so the collector deftly inserts his crooked club beneath the bird and scoops out the egg from under the hen. Naturally such a summary proceeding is keenly resented by the bird, which bites at the collector's legs. Once, however, the egg is removed the bird appears to take no further notice and the man may safely stoop to pick up the article. The collection is then packed in boxes which are dispatched at frequent intervals to the mainland in small sailing craft and disposed of. Egg collecting is not carried out every day, but a day or two are allowed to elapse between each raid. The penguins are most prolific layers, as may be shown from the fact that during the short season of three months no less than five million eggs are collected. Upon the last day of the collecting period the men make a final search and every egg on the islands is removed. The birds are then left alone through the brooding season, and in this manner, despite the wholesale robbery of their nests, they perpetuate their species in increasing numbers every year, while the fact that their ranks suffer no diminution from the hands of marauders, owing to government protection, tends to increase their value from the egg point of view, since they multiply very extensively and rapidly.

During the brooding period no guano collecting is permitted, the object being to afford the birds the utmost preservation from disturbance. The only occasional visitors are members of the Agriculture Department of the government, who repair to the islands in order to study the habits of the penguin at close quarters, which investigations have contributed very appreciably to our knowledge of these birds. After the brooding season is over the resident rangers make a thorough survey of the islands, destroying all eggs that have proved infertile, a similar action being taken intermittently during the close period, the object being to prevent the egg collectors inadvertently collecting any bad eggs when engaged in their pursuit.

The eggs, as already explained, constitute a favorite dish among the inhabitants of South Africa. They are cooked in a variety of ways, but the most popular method and one which it is stated enables the flavor of the egg to be obtained most satisfactorily is to boil it for a period of twenty minutes. This enables the yolk to become solidified, though it does not destroy the jelly-like consistency of the albumen, which retains its peculiar characteristic no matter to what extent boiling or poaching may be prolonged. The contents are then removed from the shell and minced or mashed on a plate, to which are added liberal quantities of butter, salt, and pepper. Treated in this way the egg makes a most appetizing dish, which is greatly relished. If desired, the egg may be cooked and combined with other articles of diet such as salads and mayonnaise with equal success.

THE FORMATION OF THE BOUQUET OF WINES.

SOME varieties of grapes produce, in favorable locations and good years, wines famous for their bouquet, while the same varieties yield, in ordinary conditions, wines destitute of bouquet. If, in the latter case, the must is sterilized and then mixed with a specially cultivated yeast, a bouquet of great intensity is obtained. The same result is attained by adding to the naturally fermented wine a small amount of sugar, sterilizing the mixture, and causing it to undergo a second fermentation under the influence of the special yeast. Yeast does not transmit to the must to which it is added the bouquet of the wine from which the yeast was obtained, but it develops the characteristic bouquet of the variety to which the must itself belongs.

From these facts we may conclude that the bouquet is furnished by the must, and that the latter contains bouquet-forming substances, which have not yet been isolated and which are probably different in each variety of grapes. The grapes contain these substances in all circumstances but only in favorable conditions is yeast formed which is capable of developing a bouquet from these substances. Hence the difference between the naturally fermented wines of a famous and an ordinary vintage is determined less by the quality of the grapes than by the quality of the yeast that springs spontaneously from them.

In developing the bouquet of a wine by sterilizing the must and then fermenting it with a special yeast, certain precautions must be taken. Both the temperature of sterilization and that of fermentation exert a marked influence on the bouquet. Too high a temperature of sterilization destroys the flavor of the fruit and the peculiar aroma of certain varieties. If the fermentation is conducted at too high a temperature the volatile products which constitute the bouquet are disengaged with the carbonic acid produced by fermentation.

The best temperature for sterilization is about 122 deg. F. The must, before it is sterilized, should be charged with carbonic acid, the presence of which protects the aroma from the oxidizing action of the air. Increased protection is given by the addition of a little sulphurous acid (5 or 6 grains to the gallon). Heating to 122 deg. F. only partially sterilizes the must, but it kills all germs that could cause parasitic fermentations within 48 hours, so that the fermentation, if the must is not too heavy, can be accomplished by the sole agency of the added special ferment. The fermentation should be conducted at a temperature below 68 deg. F. This process produces a richer bouquet than can be obtained by spontaneous fermentation from grapes of the same variety, except in favored locations, good years and with the aid of special precautions.

But even without sterilization and the addition of yeast it is possible to improve the product of spontaneous fermentation by properly regulating the temperature during fermentation. If the cellar becomes filled with the fragrance of the fermenting juice the temperature is too high and it should be brought down below 68 deg. F. After fermentation is well started it will not be stopped by a sudden lowering of the temperature of the vat even to 56 deg. F. It will rise again to 68 deg. F. in seven or eight days, but by that time the fermentation will be completed.—La Science au XXme Siècle.

THE GENESIS OF THE GREAT LAKES OF SWITZERLAND.

THE great lakes of the Alps are not basins formed by sinking in remote geological ages, as geologists have believed for forty years. The Alps, which are not quite as old as the Pyrenees, were formed by a folding of the crust of the earth in the tertiary period, followed almost immediately by a process of denudation and erosion which reduced their height by many thousand feet, laid bare the primitive rocks (granite and gneiss), and carried out the great valleys. The sinking of the lake basins was supposed to have occurred at this epoch.

The origin of the lake basins, however, is more recent. From a study of the hydrography of the Alps before the glacial period and a reconstruction of the original profiles of the rivers, Eisenmenger concludes that the great lakes did not exist before the arrival of the ice sheet in the quaternary period.

The lake basins, in fact, are of glacial origin. It is, perhaps, difficult to picture glaciers plowing out the basins of the lakes of Constance, Brienz, and the Four Cantons, the depths of which are 820, 853, and 702 feet. But the depth of each of these lakes is small in comparison with its length and area. The thickness of ice in the valleys in the successive glacial epochs averaged 2,600 feet, and it was from 4,000 to 4,800 feet over the sites of the lakes of Constance, Zurich, Thoune, and the Four Cantons.

The glaciers carved out the great Alpine lake basins by the attrition of their enormous mass and still more by the erosion of the waters at their base. Some of the smaller lakes were formed by the damming of valleys by glacial débris.

In regard to the ultimate fate of the Swiss lakes, Eisenmenger pronounces them to be, comparatively speaking, ephemeral incidents in the geological history of the Alpine valleys. All of them will be filled up, and many have vanished since the glacial period. In those which remain the study of the ancient deltas shows that the depth of water diminished during the quaternary period. The river Reuss annually deposits more than five million cubic feet of sediment in the Lake of the Four Cantons, and every year the Kander brings twenty-eight million cubic feet of detritus to the Lake of Thoune. Assuming the thickness of the annual layer of deposits to be 2/5 inch, the Lake of Geneva would be filled in 30,000, the Lake of the Four Cantons in 20,000, and the Lake of Constance in 12,500 years.—Cosmos.

ENLARGING AND PRINTING UPON FABRICS.

HOW PHOTOGRAPHING ON TEXTILES IS DONE.

BY A. J. JARMAN.

THE production of enlarged photographs upon muslin, sateen, silk, and cambric presents itself as something new to very many persons. The fact is, that some of the processes have been so troublesome to work, involving the use of a large and expensive negative, that by this means it has been impossible to produce a print except at a very high price. Enlargements can be made upon many kinds of fabric without the employment of a large negative.

Sateen is well suited for the work, also a good quality muslin. If the latter is used, it must be in the first place well washed in hot water a number of times, until all the starch or stiffening material has been washed out; it must then be dried, and carefully ironed out with a very clean flatiron.

An enlargement upon almost any kind of fabric can be made in just the same way as a bromide enlargement, employing either daylight or the electric arc light for the purpose; the latter being preferable, because the intensity of the light can be relied upon, there being no fear in this case of a spoiled enlargement through under-exposure.

Preparation of the Fabric.

A salting solution must be made up as follows:

Iodide of ammonium	1 ounce
Bromide of ammonium	3 ounces
Bromide of cadmium	1 ounce
Distilled water	240 ounces

A separate tray should be reserved for this solution only. The fabric must now be dipped into this, allowed to soak for a minute or two, then drawn over a glass rod, so as to eliminate the excess of liquid; the fabric must then be hung up to dry in a room free from dust, and warmed to 60 deg. or 80 deg. F. This is necessary because the ammonium salts are slightly deliquescent. When dry, the fabric must be sensitized in the following nitrate of silver bath:

Sensitizing Solution.

Nitrate of silver	5 ounces
Citric acid (crystals)	1 ounce
Distilled water	140 ounces

A tray must also be reserved for this solution only, and used for no other purpose.

All operations must now be conducted under a deep orange or ruby light. The dried salted fabric must now be placed in this solution and allowed to remain for two minutes, it being advisable to draw the fabric over a glass rod, which acts as a roller at the end of the tray, so as to secure an even sensitized surface, the glass rod being held in position by four wood clips. As soon as the fabric is sensitized, draw it over the glass rod again, and suspend it to dry by means of wood clips that have been previously coated with shellac varnish. This will prevent the absorption of the silver solution. When the fabric is dry, it will be ready for use. All that is necessary is to use a board to focus the enlarged image upon that has been well coated with shellac varnish, and so arranged that it can be made to advance or recede—in fact, a sliding screen.

If the arc light is used, a condenser will be necessary; if daylight is used, the condenser can be omitted. Fix the sensitized fabric to the board by wood clips, or clean push pins; the exposure will vary according to the quality of the negative and the distance from the source of light. In some cases ten minutes will do, and in others half an hour is necessary. Having made the exposure, the fabric is removed, and development made with the following solution:

Developer.

Pyrogallic acid (or pyrol)	1 ounce
Citric acid	1 ounce
Distilled water	60 ounces

This mixture is placed in a clean tray, and the fabric dipped into it. Now and then carefully draw through the liquid, so that every part is covered. The tray must be rocked so as to keep the developer in motion. At the end of five or eight minutes development will be complete. The fabric must now be removed and plunged into a tray of clean water, or, better still, a wooden tub. Take the fabric with both hands, wring it well by twisting it up like wringing a towel; it can now be well washed by soaking and wringing it out under a faucet of running water.

The print must now be toned, which can be done in any of the ordinary single gold toning baths, such as the following:

Saturated solution of borax	3 ounces
Water	60 ounces
Chloride of gold	2 grains

After the fabric has been passed through this bath, which will take only about a minute or two, it must be well washed again in clean water and fixed in a solution of hyposulphite of soda testing 20 or 25 on the hydrometer.

The fixing of the print takes but a short time, three to five minutes being sufficient; the material being permeable, fixing takes place more rapidly than with paper prints. As soon as fixing is complete, the fabric must be thoroughly washed in many changes of water; not merely changed from tray to tray, but well wrung out during the washing. As soon as this has been completed, hang the fabric up to dry, or nearly dry, when it may be ironed, first of all between a folded clean cloth, to flatten it out, and lastly upon the back and face of the material. The flatiron must not be too hot or there will be a variation of tone, and perhaps streaky. This operation being complete, the enlargement will present a beautiful photographic print, not only well upon the surface, but permeating the fabric itself. For the production of cushion tops this process is admirably suited.

Where the arc light is employed, three or four condensers can be used with as many enlarging screens and appliances, and thus make three or four enlargements at the same time, thus reducing the cost of production considerably. A powerful arc light is necessary, requiring from sixteen to twenty amperes, the arc lamp being so controlled by variable resistance as to suit the voltage of the electrical supply.

Prints can be made upon this material by contact with a negative under gaslight and developed, but a superior plan for constant printing consists in sensitizing the fabric with a flat camel's hair brush carried out in the following manner:

Take a piece of sateen (any color) or silk, and sensitize it by brushing the following mixture upon its face, while lying flat upon a sheet of clean glass, the sensitizer being made as follows:

No. 1.	
Distilled water	4 ounces
Citrate of iron and ammonia (green crystals)	½ ounce
No. 2.	
Hot distilled water	2 ounces
Citric acid (crystals)	½ ounce
No. 3.	
Hot distilled water	2 ounces
Nitrate of silver	½ ounce

Shake the bottle well until the salts are completely dissolved, then add No. 2 to No. 1, shake the mixture well, then add No. 3, shake the mixture well. When cold it is ready for use.

Pour some of this preparation into a tumbler, and apply to the fabric with the camel's hair brush, first lengthwise, then crosswise. Suspend the fabric to dry. All these operations can be conducted under an ordinary gaslight, except the drying, which should be carried on in the dark. As soon as the material is dry, place it under pressure in an ordinary printing frame, until required for use. The picture is printed by placing the fabric upon an ordinary negative in the usual printing frame, and exposed to direct sunlight. The progress of the printing can be watched just as printing-out paper is, when the print is just what it should be. As a finished picture it must be removed from the frame and placed aside for toning and fixing. These prints must not be left too long before toning and fixing, because the continuing action of light goes on, when the print will become too dark. The print is now washed well in half a dozen changes of water, then toned in a borax gold bath, the same as for the enlargements, also washed and fixed in the same manner; or the print can be fixed in hypo only, when a very fine sepia color is produced.

After fixing, the washing must be thorough; after this the print can be ironed with a clean heated flatiron. The hotter the iron, the darker the print will be; while with less heat the color will always incline to sepia.

If the color is not exactly what is desired, wet the fabric again, wring it out, and iron again between a folded clean towel or finger napkin, and finish by passing the iron over the face of the print.

If these photographs become dirty with use, or handling, wash them with soap and warm water, then rinse in cold water and iron again. The prints, after this operation, will be just as brilliant as the day they were made.—American Photography.

DETERMINATION OF STELLAR DISTANCE.*

WITH the exception of a hundred stars at most, we know nothing of the distances of the individual stars.

What is the cause of this state of things? It is owing to the fact that we have two eyes that we are enabled not only to perceive the direction in which external objects are situated, but to get an idea of their distance, to localize them in space. But this power is rather limited. For distances exceeding some hundreds of yards it utterly fails. The reason is that the distance between the eyes as compared with the distance to be evaluated becomes too small. Instruments have been devised by which the distance between the eyes is, as it were, artificially increased. With a good instrument of this sort distances of several miles may be evaluated. For still greater distances we may imagine each eye replaced by a photographic plate. Even this would be quite sufficient for one of the heavenly bodies, viz., for the moon.

At one and the same moment let a photograph of the moon and the surrounding stars be taken both at the Cape Observatory and at the Royal Observatory at Greenwich. Placing the two photographs side by side in the stereoscope, we shall clearly see the moon "hanging in space," and may evaluate its distance.

But for the sun and the nearest planets, our next neighbors in the universe after the moon, the difficulty recommences.

The reason is that any available distance on the earth, taken as eye-distance, is rather small for the purpose. However, owing to incredible perseverance and skill of several observers, and by substituting the most refined measurement for stereoscopic examination, astronomers have succeded in overcoming the difficulty for the sun. I think we may say that at present we know its distance to within a thousandth part of its amount. Knowing the sun's distance, we get that of all the planets by a well-known relation existing between the planetary distances.

But now for the fixed stars, which must be hundreds of thousands of times farther removed than the sun. There evidently can be no question of any sufficient eye-distance on our earth. Meanwhile, our success with the sun has provided us with a new eye-distance, 24,000 times greater than any possible eye-distance on the earth. For now that we know the distance at which the earth travels in its orbit round the sun, we can take the diameter of its orbit as our eye-distance. Photographs taken at periods six months apart will represent the stellar world as seen from points the distance between which is already best expressed in the time it would take light to traverse it. The time would be about sixteen minutes.

However, even this distance, immense as it is, is on the whole inadequate for obtaining a stereoscopic view of the stars. It is only in quite exceptional cases that photographs on a large scale—that is, obtained by the aid of big telescopes—show any stereoscopic effect for fixed stars. By accurate measurement of the photos we may perhaps get somewhat beyond what we can attain by simple stereoscopic inspection, but, as we said a moment ago, astronomers have not succeeded in this way in determining the distance of more than a hundred stars in all.

In the Illuminating Engineer, Mr. B. Dushnitz describes a new form of glow lamp that has been developed in Germany. The filament of the lamp is composed of carbon, but burns in an atmosphere of mercury vapor instead of *in vacuo*, as in the case of lamps of the ordinary variety. This atmosphere of mercury vapor is secured by the volatilization of a drop of mercury placed within the U-tube containing the filament. The lamp is said to consume about 1.5 to 1.7 watts per candle-power, and such results as are at present to hand regarding the life of the lamp are looked upon as satisfactory. The author quotes the results of a series of experiments by Dr. Lux, having for their object to determine whether the increase in efficiency is to be ascribed to high temperature or luminescence. The conclusion is reached that the former explanation is the correct one, the envelope of hot mercury vapor restricting the conduction of heat from the filament and so raising its temperature of incandescence.

* Abstracted from a paper read before the Royal Institution by Prof. J. C. Kapteyn.

THE CARRIER PIGEON PHOTOGRAPHER.

A NEW USE FOR THE HOMING PIGEON.

BY DR. NEUBRONNER.

PHOTOGRAPHIC "bird's eye views" have hitherto been obtained by means of balloons, kites, or rockets. I have discovered that they may be taken also with the aid of carrier pigeons. More than fifty years ago my father, an apothecary, employed pigeons to bring prescriptions from neighboring villages, in the Taunus Mountains, and I have continued the practice. One

FIG. 1.—DOUBLE PIGEON CAMERA FOR TWO EXPOSURES.

day it occurred to me that small quantities of medicine might be brought by the same means from Frankfort, about 10 miles away. The medicines were inclosed in glove-fingers, which were slung about the bird's wings. The method proved entirely successful and I have made much use of it. Experience has shown that a pigeon can carry a properly distributed load of 2½ ounces to a distance of 100 miles.

On one occasion, a pigeon which had been released in a dense fog, did not arrive at its cote until after the expiration of four weeks. As I was wondering

FIG. 2.—PIGEON CAMERA FOR EIGHT EXPOSURES ON A STRIP OF FILM.

where the bird had been, it occurred to me that a pigeon equipped with a self-acting camera would bring in a photographic record of its journey.

It was not easy to construct an automatic camera with a maximum focal length of 2 inches and a maximum weight of 2½ ounces, including all appurtenances, but the problem was finally solved by a Frankfort firm. Fig. 1 shows one form of the apparatus and Fig. 3 shows how it is attached to the pigeon. It comprises two complete cameras, with their lenses directed forward and backward, so that at least one land view is obtained when both plates

FIG. 3.—PIGEON CARRYING DOUBLE CAMERA.

FIG. 4.—PIGEON CARRYING CAMERA FOR EIGHT EXPOSURES.

are exposed simultaneously in any position of the bird. The cameras are mounted on a thin aluminium cuirass which is attached to the bird by straps and rubber bands.

The shutter is released by the spoon-shaped lever shown at the right of the illustration (Fig. 1). The bowl of the spoon is pressed outward by a hollow rubber ball filled with compressed air and perforated by a very small orifice. As the air slowly escapes, the ball collapses and the lever moves until it releases the shutter and makes the exposures at a moment that can be pretty accurately determined in advance. The pictures are 1½ inches square. Another form of the apparatus (Figs. 2 and 4) contains a single lens and a strip of film on which eight pictures are taken at definite intervals with the aid of the air ball and clockwork. The number of pictures may probably be increased to 24 or 30.

The carrier-pigeon photographer can render valuable service in many fields, and especially in the field of war, for obtaining information of the country and the position and strength of the enemy. The Prussian Minister of War has shown interest in the project and has put at my disposal birds from the military pigeon station at Spandau, with which successful experiments have been made. The carrier pigeon flies at a height of between 150 and 300 feet, safe from small shot and very difficult to hit with bullets. Pigeons might be released from airships at any height within the

FIG. 5.—A PHOTOGRAPH TAKEN BY A CARRIER PIGEON.

enemy's lines, and they would carry home with them pictures of great value. The carrier pigeon is peculiarly well suited to service of this character because, when set free in a strange place, it commences its flight by describing a spiral curve, in the course of which several pictures could be taken from various points of view. Then, when the pigeon has determined the position of its goal, it flies thither in a straight line at a uniform speed of about 40 miles per hour. As the moment of exposure can be regulated with a fair degree of precision the object which

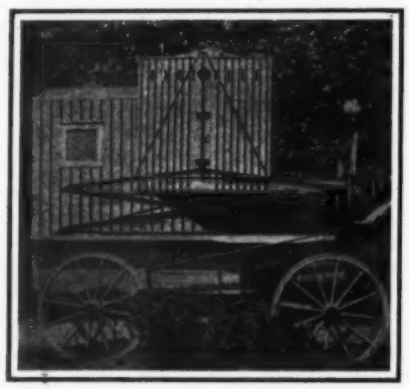


FIG. 6.—ARMY WAGON CARRYING PIGEON COTE AND DARK ROOM.

it is desired to photograph can generally be caught. In besieged fortresses information concerning the besiegers can be obtained by tumbler pigeons which, when released at their home, fly in circles for a time and then return to their cotes.

In field service it will be necessary to provide portable cotes for the carrier pigeons. Many strolling players are accompanied by pigeons which return regularly to the caravan at night. A pigeon can see and recognize its cote at a distance of more than 20 miles. I have devised a wagon carrying a developing room and a cote which can be raised on "lazy tongs" in order to release the pigeons at a good height. I am rearing a number of young pigeons in these portable cotes for the purpose of photographing the fortress-like dam at Tegel, which I am allowed to approach to a distance of 1¼ miles on every side. This problem was proposed by Major Gross, chief of the balloon corps.—Umschau.

ARC SPECTRA OF METALS UNDER PRESSURE.

A REMARKABLE paper was read by Dr. W. Geoffrey Duffield, of Manchester University, on "Photographs of

FIG. 7.—THE COTE ELEVATED ON "LAZY TONGS."

Arc Spectra of Metals under Pressure," before the British Association for the Advancement of Science. His pressure vessel, Dr. Duffield stated, was one of Petavel's solid-drawn-steel cylinders, 2 feet long, 3 inches in internal diameter, 1 inch wall thickness, closed by stuffing-boxes, through which the electrodes passed. The vessel was provided with a window and water-jacketed, and the arc was steadily kept on the slit, with the aid of a partly-movable system of lenses and mirrors. The pressure had been raised to 120 atmospheres. The first effect of pressure was a broadening of the lines, chiefly on the red side, different for different lines; there was also a shifting toward the red apart from the broadening. As to this displacement, however, the various iron lines differed strongly, their relative displacements being in the ratios of about 1 : 2 : 4. That relation was disturbed for pressures lying between 15 and 30 atmospheres, for which reversals were frequent. The phenomena suggested series of lines; some lines, unreversed at 1 atmosphere, would not reverse at all, others always remained reversed, and the reversal might be asymmetrical. Most lines did not change in brilliancy with increased pressure; some became enhanced, some weaker. The series lines of copper vanished under high pressure, those of iron hardly; the line spectrum of silver changed into a band spectrum at higher pressures, and finally became a continuous spectrum.

In the discussion of the paper, Prof. W. F. Barrett referred to the work of the late W. E. Wilson on the temperature of the arc under pressure, and to the

FIG. 8.—WORKING IN THE DARK ROOM.

contradictory results of the subsequent experiments by Wilson and Fitzgerald, and inquired whether Dr. Duffield had attempted to measure temperatures in his experiments. Dr. Duffield replied that photometric measurements were in progress, but that the fluctuations of the arc at high pressures, and the fact that the brightness seemed to vary with the amount

air present, made the determination of absolute values very difficult. In the case of the copper and silver arcs the brightness increased to such an extent that at the highest pressure the image of the arc on the slit was painful to behold; that seemed to indicate that the temperature also increased enormously with the pressure.

Considering all these difficulties and the radical changes in spectra which Goldstein has recently obtained with exceedingly powerful sparks, the interpretation of spectroscopic evidence becomes more and more complicated, and great caution seems advisable in cosmical physics, where we may have to deal with temperatures and pressures and other conditions unattainable in our laboratories.

POLICE SIGNALS FOR PUBLIC USE.

RIO JANEIRO'S NOVEL SYSTEM.

BY OUR BERLIN CORRESPONDENT.

A POLICE signaling plant of unique design has recently been constructed for the city of Rio de Janeiro. Five hundred and eight boxes resembling in general design a fire-alarm box are installed throughout the streets of the city proper. Every citizen is authorized to purchase a key with which he will be able to call for police assistance from any of the boxes. The key does not open the box, but when inserted in the keyhole and turned, it serves to release a train of gears which signal to the nearest police station the characteristic number of the alarm. This number is registered by a recording apparatus on a tape of paper with the time of signaling, while an incandescent lamp signal is lighted at the same time, the whole process going on quite automatically at the police station. The official in charge of the recording apparatus reads the number signaled from the alarm box and by means of an ingenious apparatus transmits it to the nearest police post, of which there are forty in the city. At the post the alarm is sounded on a gong which strikes the number of the box and at the same time the number appears on a sign, while a record of it with the time is automatically taken. On receipt of this alarm the post, which comprises about six police and a car, ready for immediate duty, starts out. The whole process, as far as the signaling is concerned, takes but a few seconds, so that police assistance in any case can be expected within a couple of minutes.

Policemen, on the other hand, are enabled by the aid of another key, giving access to the interior of the alarm box, to send various signals for accidents, fires, etc., by simply setting a pointer to the corresponding legend on a dial. They are, furthermore, in position, by the aid of a telephone apparatus provided with each alarm, to communicate direct to any point of the police alarm system. Finally, both the main station and the six secondary police stations (exclusive of the forty police posts) may call to the nearest alarm box any policeman in the streets by means of light signals at night and sound alarms during the day and communicate with him by telephone.

The system further serves for checking the policemen on their beats. Each policeman is required to proceed from one alarm box to another and to register by signal. Police sergeants and officers are in a similar manner obliged to give certain signals during patrol.

PRACTICAL RESULTS OF ELECTRIFICATION.

WILLIAM S. MURRAY, electrical engineer of the New York, New Haven & Hartford Railroad Company, which has been operating the Westinghouse single-phase electric railway system on a part of its lines during the last two years, in discussing his experiences with electrification, has this to say, according to the Boston News Bureau:

"The most commercially valuable answer as to the success of electrification on the New Haven is written in the actual operating schedule in the electrification zone. The train-minute delays suffered to-day by electrical operation are but a small percentage of those incurred during the period of steam operation.

"As the zone limits in our case were not a terminal proposition, the application of the direct current showed itself to be impracticable. On account of errors, always common in initiative work, the first few months' operation has been a period of interruption, which has naturally been annoying both to the road and the public. To-day the delays have disappeared by the removal of their cause.

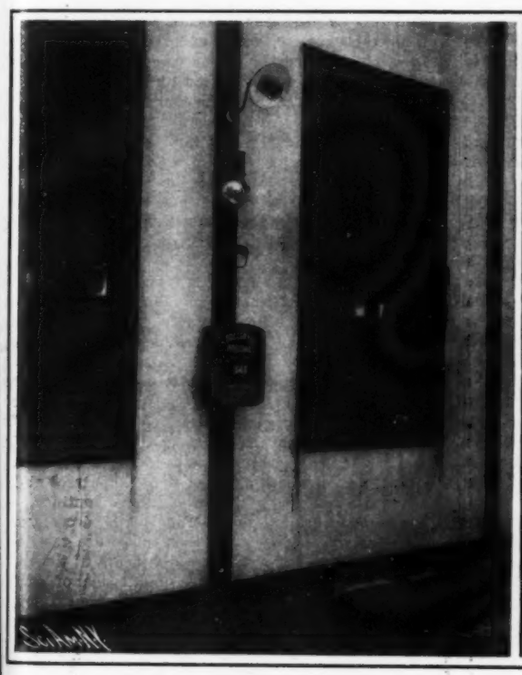
"The wisdom of the purchase of a locomotive consisting of two individual half units, the whole or half unit being operative by a single crew, has proved itself in the ability of the road to handle 75 per cent of traffic with half-unit locomotives, using the whole unit on the remaining 25 per cent of trains, whose weight demands the full drawbar. Should future requirements see the advantage of extension of electrification east of Stamford, the system is designedly applicable.

"As to the saving in cost of operation as compared with steam, I would state that operation to-day has not been a sufficient length of time to make this comparison. It may be interesting to note, however, that by exhaustive investigation I have found that one pound of coal burned under the boilers of our central station produces twice the drawbar obtained by one pound of coal burned in the fireboxes of the steam locomotive, or, in other words, the fuel bill for electric traction is one-half of that required for steam traction. Other economies will arrive in the low cost of maintenance and repairs of the electric locomotive as against steam locomotives.

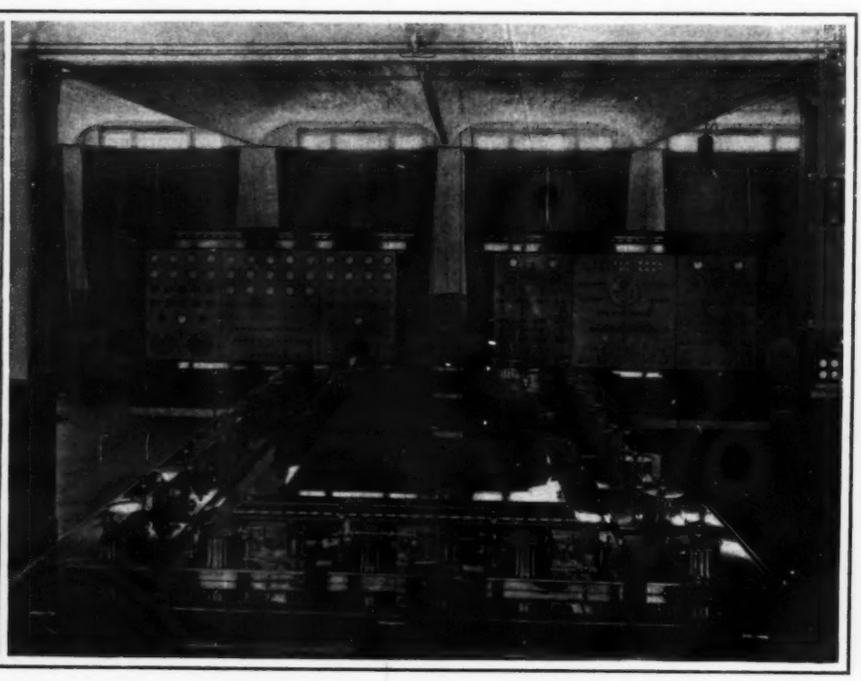
"The density of traffic is, of course, the paramount feature as to the savings to be effected by electrification. It is not to be forgotten that, in electrifying, interest, depreciation, insurance, and taxes follow closely on the heels of the capital investment in equipment and material necessary to electric operation. The heavier the traffic, the greater will be the economies derived from the two above-mentioned sources.

"It is quite conceivable that the heavy ton-mileage in freight and passenger service on the Atlantic coast-line roads will effect savings sufficient to cover the above-mentioned fixed charges on the investment necessary to their electrification.

"The greatest value to be experienced by electrification will be in the tremendously increased traffic capacity of the present track mileages, due to the facility electricity offers in making rapid main-line and yard-train movement, or, stated in another way, it is thus immediately seen that electrification will permit a tremendous increase of traffic without an increase of track mileage, and thus roads which are up against the requirement of handling their congested traffic by laying new tracks, which, of course, is a most expensive procedure on account of right-of-way difficulties, will be led into providing an equal capacity by electrification of the old trackage."



A POLICE ALARM BOX.



THE RECEIVING APPARATUS AT THE CENTRAL STATION.

A POLICE SIGNALING SYSTEM FOR PUBLIC AS WELL AS OFFICIAL USE.

To Make Petroleum Barrels Tight.—Dissolve 125 parts of rosin, 125 parts shellac, 2,000 parts of turpentine, 100 parts of yellow wax, in 2,000 parts of alcohol, and rinse the barrels out twice with this mixture. As soon as the coating is dry, repeat the operation with a solution of 1,000 parts of shellac in 500 parts of alcohol. One thousand parts of leather waste is treated in a water bath in 125 parts of oxalic acid, previously dissolved in 2,000 parts of water, and as soon as it is dissolved the mixture is gradually thinned with 3,000 parts of warm water and the barrels are treated with this. When the mass is dry, it absorbs oxygen and turns brown.

MARVELS OF A PLANT'S GROWTH.*

THE CHEMISTRY OF DECAY.

BY PROF. VIVIAN B. LEWES.

IN the whole of Nature's wonder-book there is nothing that appeals more to our sense of the marvelous than the way in which all the waste of animal and vegetable life is converted by decay into those simple compounds, carbon dioxide and water vapor, which are again used in the wonderful processes by which all forms of life are synthetically recreated.

It is the sun's rays which are the mainspring of this regeneration, and the growth of vegetation is the means by which it is brought about. All the ordinary forms of plant in which the green pigment known as "chlorophyl" is present, owe their growth to energy derived from the sun, under which the chlorophyl contained in the small glands of the plant absorbs carbon dioxide and water vapor from the atmosphere, while more moisture and traces of mineral salts are drawn in by the roots. Once absorbed the carbon dioxide and water vapor under the influence of the chlorophyl commence a marvelous series of changes, which result in the formation of the first visible product, the starch granules and also sugars, which afterward become practically the food of the plant, and are incorporated as the cellulose or woody fiber, of which the solid portion chiefly consists, the completed reaction being of some such nature as that expressed by the equation—

$$\underset{6\,CO_2}{\text{Carbon dioxide}} + \underset{5\,H_2O}{\text{Water vapor}} + \text{Sun's energy} = \begin{cases} \text{Cellulose} \\ C_6H_{10}O_5 \end{cases} + \underset{6\,O_2}{\text{Oxygen}}$$

And it is this oxygen so liberated in the early days of the world's creation which according to some theorists formed the atmosphere, and has since kept the oxygen present in it a practically constant quantity.

It must be borne in mind, however, that, although such an equation is capable of representing the sum of the actions taking place, yet it only in reality represents the first and final stages of a series of most wonderful and beautiful reactions, the exact course of which is but little understood. The fact that the sun's energy is necessary to bring about this reaction is made manifest by the growth of vegetation when kept from the light, when it merely gives rise to a few sickly and colorless shoots formed by the plant food already stored in the plant or seed, while on the other hand recent experiments have shown that ordinary vegetation can be accelerated in its growth by the illumination from certain forms of artificial light during the hours of darkness.

Probably the first attempt to use artificial light for hastening the growth of plants was made in 1861 by Hervé-Magnon, while twenty years later Siemens, by experimenting with an arc lamp of 1,400 candle power, placed 10 feet from the plants, with a glass screen interposed, came to the conclusion that this illumination was capable of producing an effect equal to about half that of the sun. In more recent years various artificial lights have been employed for accelerating growth, and it has been found that nearly all plants, aided in their development by artificial light to which they are exposed during the usual hours of darkness, reached the flower and fruit bearing stage much earlier than with sunlight alone, some few, however, like the onion, declining to be hurried. That this growth and progress is not at the expense of root formation is abundantly proved in the case of such plants as radishes, in which not only was the top growth three times that of a similar plant growth in sunlight alone, but the root growth also amounted to 2½ times the normal in a given time.

From the exhaustive researches which have been made upon plant life, it seems fairly clear that the function of the chlorophyl in the growing plant is practically three-fold. It has been shown that it is those rays in the immediate neighborhood of the red and orange in the spectrum which most keenly excite the assimilation of carbon dioxide and water vapor, and that the chlorophyl absorbs those rays which hinder the formation of carbo-hydrates, transforming rays of short wave-lengths into those rays which most favorably effect the production of the sugars and starch, which are the food of the plant structure, and that it also acts by the conversion of light into heat.

The usual statement that the solid matter of the plant consists of cellulose is, of course, only an approximation to the truth, as cellulose is only one of several modifications produced by the actions taking place in the growth of the plant; but as from a calorific point of view the other organic bodies present have practically the same thermal value, it is a convenient simplification to take wood as being composed of cellulose, water, and the constituents of the sap, mineral salts and extractive matters, which may be resinous (as in coniferous woods), extractive (as in beech or birch) or tannin (as in oak).

The chemical actions which have resulted in the formation of the cellulose have required an expenditure of energy which, in the primary decomposition of the carbon dioxide and water vapor, can be expressed in terms of the heat necessary to raise a unit weight of water one degree.

A unit weight of carbon in burning to carbon dioxide raises 8,137 units of water 1 deg. C., or 14,647 units of water 1 deg. F. The former we speak of as "calories" and the latter as "British thermal units."

In the same way a unit weight of hydrogen in burning to form water develops 34,500 calories, or 62,100 British thermal units, and in order again to decompose the carbon dioxide and water so as to liberate the unit weight of carbon and of hydrogen, just as much energy expressed in heat units will be absorbed. As in the growth of the plant this energy has been derived from the sun, and has been partially rendered latent in the cellulose, when we burn that compound in the form of wood so as again to convert the carbon and hydrogen to carbon dioxide and water vapor, we once more set free the stored energy in the form of heat and can render it available for heating purposes.

The variations in the physical properties of wood are dependent upon the constituents of the sap and the density with which the solid matter is packed away in the structure, and when the wood comes to be burnt its calorific value is found to vary slightly owing to these factors, and also to the amount of moisture which it contains; as upon the constituents of the sap will largely depend the amount of ash which is formed, and upon the moisture the amount of heat which will be rendered latent in the conversion of the water into steam. Moreover, in the formation of the cellulose oxygen equivalent in quantity to that which was originally in combination with the hydrogen will have been again taken into combination in the formation of the plant's structure, with the result that air-dried wood, when tested for its calorific value, is but a poor fuel. The figures obtained with various kinds of wood, when tested in the Mahler bomb, are shown in the following table:

CALORIFIC VALUE OF WOOD.

	Calories.	British Thermal Units.
Ash	4,771	8,480
Beech	4,774	8,591
Birch	4,771	8,586
Elm	4,728	8,510
Fir	5,035	9,063
Oak	4,620	8,316
Pine	5,085	9,153

The moisture present in a sample of wood will vary enormously with the time of year at which the tree has been cut down, and also with the nature of the tree, so that while as little as 18 per cent of moisture has been found in one kind of wood, it may exceed 50 per cent in another, while, under the most favorable conditions, air drying will only reduce the moisture in wood to form 18 to 20 per cent. It may, therefore, be roughly stated that at the best, wood will only contain 80 per cent of combustible matter, while the large amount of heat absorbed in heating and evaporating the water present is a serious drawback to it as a fuel.

The combined oxygen also present in the cellulose, as has been before indicated, seriously detracts from its value, and where wood is the only fuel that can be employed, and great local heat is required, a fuel of practically double the value of wood can be obtained by its conversion into charcoal before use. Under the influence of destructive distillation the contained moisture and combined oxygen are driven forth as water vapor; and although four-fifths of the weight of the wood is lost in the liquid and gaseous products escaping, yet the 20 per cent of carbon that remains on burning is free from the drawback of having the intensity of the heat of combustion lowered by the rendering latent of heat, which, in the case of wood, was lost in vaporizing the water and bringing about the decomposition.

In the same way that human beings and animals of the present day are of a very different and higher type to those which first appeared on the earth's surface, so our plant life has undergone a great alteration in character, and as we trace by the light of geology the birth and growth of vegetation, we are led to the conclusion that as the earth cooled down, soil was first formed upon its rock surface by the disintegrating action of water containing carbon dioxide and by those processes to which we usually give the name of "weathering." Spores of the lower forms of plants, like lichens and mosses, then appeared, and in their growth fixed the carbon and hydrogen from the carbon dioxide and water vapor to the atmosphere. By their decomposition they supplied the soil, which up to that time had been of a purely mineral character, with the organic constituents necessary for the growth of vegetation of a higher order.

This next form of vegetation, urged on in its growth by the heat permeating from the cooling mass of the earth, and fed by the excess of carbon dioxide and moisture in the air and the virgin soil in which it grew, attained a rapidity and luxuriance of growth which probably has never been equaled. In type it consists chiefly of cryptogamic plants, such as club mosses, sedges, and other forms of marsh vegetation, which, however, instead of growing to a height of a few inches, attained enormous dimensions. Dying down year by year they formed a densely packed mass of vegetable matter, which undergoing the process of checked decomposition of the same character as can be recognized in the past deposits of the present day, gradually built up those masses of semi-decomposed vegetable matter which were afterward converted by time, heat, and pressure into the coal seams.

The formation of peat is apparently due partly to fermentation when exposed in its wet state to air, and partly to checked decay when covered with water, and it is the latter process which is the most valuable in converting it into a form which is available for fuel.

When decomposing matter is freely exposed to moist air, processes of fermentation and still further oxidation convert it ultimately into carbon dioxide and water vapor, leaving as a residue only the mineral matters and more resistant hydrocarbons, the latter in turn also disappearing, and it is by such processes of decay that Nature cleanses the surface of the earth from all waste vegetable matter. When, however, the dead vegetation has its decay checked by immersion in water or the deposition over it of silt or soil of such a character as to cut off from it the supply of atmospheric oxygen, the processes of decay continue, but instead of exterior oxygen acting on the decomposing molecules, the changes that take place are restricted to those set up between the constituents of the molecule itself, and result in the elimination of carbon dioxide, water, and methane, with consequent lowering of the proportion of hydrogen and oxygen left in the residue.

Enormous areas of peat exist at the present day not only in the British Isles, but in even greater quantities in Russia, Sweden, Norway, Germany, and Finland, while in Canada and America the peat bogs are still more vast, and in the future this material will probably play an important part in the supply of fuel when the depletion of our coal supplies drives us to utilize these natural stores.

The great interest, however, attaching to peat at the present moment is that the same action which converts cellulose into peat will, if continued under conditions of considerable pressure and higher temperatures than ordinarily exist at the present day, convert the peat deposits into a coal seam.

Taking the luxuriant vegetation of the carboniferous era, it is easy to imagine the way in which the huge peat bogs were formed in the low-lying watersheds, and in which the agglomeration of vegetable matter swept down by the hurrying streams accumulated in the deltas of the prehistoric rivers, while the volcanic actions which marked this period would often cause so great an alteration in the earth level that the decomposing vegetable matter became subject to the inrush of water bearing with it huge quantities of mud and silt, which, depositing above the collected vegetation, gradually hardened there and formed the strata which we find above the coal.

Nor were these actions confined to that particular period to which we look back as the carboniferous age. We find that whenever the conditions were favorable for the deposition of great beds of vegetable matter, actions of a similar nature have led to its conversion into coal in strata of a more modern character, and the formation of coal appears to have been going on ever since the inception of vegetable life on the earth's surface, and there is no reason to doubt

* Abstracted from the Journal of the Society of Arts.

that the swamps and bogs of the sub-tropical forests of the present day are to a minor extent carrying on the early stages of the same action.

The chemical actions that took place during the period when the peat deposits, heated from below by the earth's temperature and pressed on by the superincumbent deposits above them, underwent those changes in composition which we now recognize in our coal, can be traced by analysis, and the following table indicates the way in which the gradual elimination of the hydrogen and oxygen altered the cellulose of the growing plant to the product of our coal seams:

THE CONVERSION OF WOODY FIBER TO COAL.

(Butterfield.)

	Carbon.	Hydrogen.	Oxygen.	Nitrogen	Sulphur.	Ash.
Cellulose	44.4	6.2	49.4	—	—	—
Dry wood (average)	48.5	6.0	43.5	0.5	—	1.5
Dry peat	58.0	6.3	30.8	0.9	trace	4.0
Lignite	67.0	5.1	19.5	1.1	1.0	6.3
Coal	77.0	5.0	7.0	1.5	1.5	8.0
Anthracite	90.0	2.5	0.25	0.5	0.5	4.0

This action is made even more manifest by calculating the analyses so that the carbon is kept as a fixed quantity, which brings into bold relief the gradual elimination of the other constituents of the cellulose.

THE CONVERSION OF WOODY FIBER TO COAL.

(Percy.)

	Carbon	Hydrogen.	Oxygen.
Wood	100	12.18	88.07
Peat	100	9.85	55.67
Lignite	100	8.37	42.42
Bituminous coal	100	6.12	21.23
Anthracite (Wales)	100	4.75	5.28
Anthracite (Penna.)	100	2.84	1.74
Graphite	100	0.00	0.00

These changes in composition may also be traced in the calorific value, and show the thermal advantages gained by the elimination of the oxygen during these processes of natural distillation.

	Calories.	British Thermal Units.
Wood	4,771	8,588
Peat (dry)	5,600	10,080
Lignite	7,000	12,600
Bituminous coal	8,446	15,203
Anthracite	8,677	15,618

It is not, however, time alone which causes alteration in the character of coal. The factors of temperature and pressure also play so important a part in its composition that it is unsafe to base any far-reaching ideas as to the age of a coal upon the amount of natural carbonization which it has undergone. One may look upon coal as consisting of a basis of carbon together with the mineral matters that were mostly present in the sap of the plant, and on the combustion of the coal will remain behind as ash, these forming the solid residue which is left on heating the coal out of contact with air. The portion which under these conditions escapes, and may therefore be termed the volatile matter, consists of various compounds of carbon and hydrogen and other more complex bodies containing not only these elements, but also the oxygen and nitrogen present in the coal.

The proportion of volatile matter present, consisting as it does largely of hydrocarbons, makes a wonderful difference to the way in which a coal burns, the presence of hydrogen and lower members of the hydrocarbon series giving the coal ease of ignition and the property of burning with flame, while the more complex hydrocarbons and organic bodies render the flame so produced heavy and smoky in its character. If a coal which contains a very small percentage of volatile matter, such as anthracite, be taken, it is found difficult to ignite and almost impossible to burn without specially arranged conditions of draft, while the more bituminous coals, such as cannel, can be ignited by the flame of a match, and will burn with the greatest ease.

With the increase in bituminous matter in the coal, the fixed carbon or coke left on distillation naturally decreases in quantity, and coals are generally classified on the basis of the amount of fixed carbon they contain into lignites, cannels, bituminous coal, steam coal or semi-bituminous coal, and anthracite, the percentage of carbon varying from 65 per cent in some lignites up to over 90 per cent in the anthracites. The relation existing between the composition of the coal and its powers of smoke production is one that will have to be discussed again in considering the fitness of fuels for the class of work they have to perform.

Any form of bituminous coal when subjected to a raised temperature begins to yield products of a liquid and gaseous character; and if the temperature be kept at the lowest point at which any action can take place, the liquid distillates formed are of an oily character and not greatly dissimilar to some crude mineral oils. Indeed, it seems highly probable that when the coal has been formed under conditions where no escape of gaseous matter could take place owing to the impermeability of the low-lying strata, a natural distillation at very low temperature has gone on over long ages and some of the bituminous products of the decomposition distilling into the earthy strata next to the coal have formed with it the shales which differ from coal in that the fixed residue left on their distillation consists of earthy matter instead of coke. It is also perfectly well known that in some of the more extensive peat bogs a trickle of oil is occasionally found escaping from the decomposing mass, showing that even in the early stages of the action, oils are produced, while it was from a spring of oil in the shale measures of the Alfreton Colliery that Young first got the idea of utilizing shale for distillation as a source of mineral oil.

It has been known for centuries that in certain districts of America and Eastern Europe a scum of oil would frequently gather on the surface of the pools and streams, and these districts have since become famous as the great sources of American and Russian oil supply. Although many observers cling to the belief that the oil fields have been formed by animal or mineral agency, there seems but little reason to doubt that our liquid fuels, like the solid, are of vegetable origin, and are indeed by-products of great subterranean distillations, in which at high pressures and comparatively low temperatures the accumulated vegetation of past ages has been partly liquefied or even gasified, as the same areas which yield our stores of mineral oil are also famed for the production of natural gas.

The Pennsylvania oil fields of America yield crude oil consisting largely of members of that group of hydrocarbons which we know as the "saturated series," the lower and more simple members of which are gases, and with the fifth member commence to give highly volatile liquids yielding the pentane which we use for our standard of light, and the hexane and heptane known as "petrol" in England and "gasoline" in America, while higher members of the series constitute the burning, lubricating, and fuel oils which have played so important a part in the technical world during the past fifty years.

The Russian oils, on the other hand, contain hydrocarbons of a slightly different character, having as chief constituents "naphthenes," a group which, although in many properties similar to the saturated hydrocarbons, yet in composition must be ranked with the unsaturated. So laborious, however, is the separation of the hydrocarbons present in these great natural distillates, that our knowledge of their constituents is still far from perfect, and recent researches upon the tars obtained at low temperatures from coal show that they are characterized also by the presence of the naphthene group.

The valleys of the Allegheny, which gave so abundant a supply of oil to Drake and the pioneers of the oil industry in the early sixties, also yielded that great output of natural gas which concentrated the manufacturing activity of America to so large an extent in these districts. Although such gas is found in small quantities in many parts of the world, no output of the same magnitude has ever been discovered.

This gas, which is by far the most valuable of the gaseous fuels, is practically methane, its character being indicated by the following analysis:

COMPOSITION OF NATURAL GAS.

	Russian (Baku).	American (Ohio).	English (Heathfield).
Hydrogen	0.98	1.89	0.00
Methane	93.09	92.84	93.16
Ethane	3.26	0.35	2.94
Carbon dioxide	3.18	0.75	0.00
Nitrogen	0.49	3.82	2.90
Oxygen	0.00	0.35	0.00
Carbon monoxide	0.00	0.00	1.00

Weight for weight natural gas is the most valuable of all the fuels, having a calorific value of 12,008 calories (21,615 British thermal units), and its history affords a graphic object lesson of what within a hundred years will be our condition with regard to coal supply, the actions, however, having been concentrated into a period of not less than 50 years.

With the first discovery of natural gas waste of the grossest character took place, followed by a period in which, the value of the gas having been realized, it was consumed with the utmost prodigality, and no thought was ever given to the future. Then as reduced pressures in the supply began to give a warning note, economy at length began to be exercised, while now the rapidly decreasing supply threatens failure at an early period and has at length forced attention to every point at which economy can be obtained.

ELECTRON HISTORY.*

By SIR OLIVER LODGE.

THE first inkling of the discovery of the atomic nature of electricity dates back to Faraday and his experiments in electrolysis. The indivisible atomic charge—the charge of a monad ion—was then practically measured, at least as soon as the size of the atom was known; and an "atom of electricity" was spoken of, both by Maxwell and by Helmholtz. In amount, measurement indicates that it consists of 3.4×10^{-10} electrostatic unit, some uncertainty affecting the second significant figure. On this basis, Dr. Johnstone Stoney gave to these unit charges their name "electron," and speculated ingeniously on some of their properties. Then J. J. Thomson found that in the rarefied air of a vacuum tube these charges were loose, flying as cathode rays; and identically the same, no matter what was the kind of residual matter in the tube. It was in this state that their mass was measured, and found to be a thousand times less than the previous material minimum—the hydrogen atom. Then Zeeman found that their orbital motion was the source of all bright line spectra—that is to say, that they emitted radiation, carving the ether into waves.

The conduction of electricity is due to the procession of electrons and positive charges; and the good conducting power of metals, whether for heat or for electricity, is supposed to be due to a crowd of electrons freely permeating the interstices between the atoms, being handed on from one to another so readily that they are practically dissociated or free in vast numbers. And the long-known connection between heat conductivity and electric conductivity is found to be thus rationally and quantitatively accounted for.

Furthermore, the regular gradation of electric properties exhibited by the elements in Mendeléef's classification can be stated electrically, in a way that certainly suggests an approximation to the truth. Each octave has an electro-positive and an electro-negative end, the most extreme members being at the ends, and an almost neutral body in the middle, of each series; and in the step from the extreme electro-positive of one octave to the extreme electro-negative in the next, an intermediate halting place of a neutral and quite inert body is now known, by the discovery of the argon-krypton-xenon series.

The atoms of the electro-negative set are those which can easily make room for, and have acquired, extra electrons—more than properly belong to their constitution; these are the non-metals, and are chemically active on that account. The atoms of the electro-positive variety are those which easily lose, and have lost, some of their electrons—thereby becoming good conductors by reason of the loose electrons which they have let go; these are the metals. A strong electric attraction naturally exists between members of the electro-negative and the electro-positive group, because they are oppositely charged; and the clinging together of these atoms, under electric attraction, constitutes chemical combination. Conducting power usually disappears after combination, except the variety of it which may be brought about by the dissociation or breaking up of the compound molecules.

The epithets positive and negative, which from the electrical point of view seem so interchanged and inconvenient, from the material point of view get right again. For the atom which is hungry for more electrons and has absorbed them is electro-negative; while the atom which has a surplus and has extruded some is electro-positive. A tetrad can be either the one or the other. In methane the carbon is presumably acting as a negatively charged body. In carbon tetrachloride the carbon is presumably acting as a positive. Chlorine seems to have much more residual affinity than hydrogen has, and accordingly the molecules tend to cling together, and the substance is a liquid instead of a gas.

Once more I repeat that the term in Van der Waal's famous formula, $\frac{a}{v^2}$, or Laplace's K, is the liquefying force, and is a measure of this outstanding affinity; it is determined by the latent heat of evaporation, or to some extent by the boiling point and the critical point.

* Journal of the Society of Chemical Industry.

Benzine gelatine for cleansing purposes, for the removal of spots of all descriptions, from any fabric, is prepared as follows: 120 parts of white soap are dissolved in a quart flask in 180 parts of hot water, 30 parts of spirits of sal ammoniac added and the flask filled three-quarters full of water, then completely filled up with benzine and well shaken. Of this mixture, take a teaspoonful and mix it, in a one-fourth quart flask, with some benzine. After thorough mixing, the bottle must be completely filled, thoroughly shaking the while, with benzine. With this gelatine, it is claimed any spots may be removed, without injury to the most delicate fabric. The gelatinized benzine evaporates very slowly.

SCIENCE NOTES.

Speaking before the Trans-Mississippi Congress, David Starr Jordan remarked: "Twenty-eight years ago in my report on the salmon fisheries of the Columbia I called attention to the fact that these fisheries would be depleted or destroyed unless the government of the United States could intervene between Oregon and Washington. In each State fishermen try to take all they can get and the two Legislatures can never agree on joint action of any kind adequate for the protection of the species. This has gone on from bad to worse until the Columbia fisheries are but a fraction of what they were in 1880. At the present time under the referendum laws of Oregon, all fishing above tide water is forbidden in Oregon, and all gill net fishing by night below tide water limit is also prohibited. This practically closes all fishing on the Oregon side, while on the Washington side there is no limit of any kind. These statutes may be set aside by the courts—one or both of them—but meanwhile very few fishes reach the spawning grounds, and the fisheries four years hence will amount to nothing. All this comes from a struggle, carried into politics, between the associated (gill net) fishermen on the one hand and the owners of the fish wheels up the river on the other."

The Action of Radium Emanation on Solutions of Copper Salts.—Last year the sensational announcement was made by Ramsay and Cameron that they had observed the production of alkali metals, particularly lithium, in solutions of copper salts which had been subjected to the action of the radium emanation. These results appeared to be of so much importance that Mme. Curie and Mlle. Gleditsch have attempted to reproduce them. In the first place they placed a solution of copper salt in a little glass flask into which a large quantity of emanation was introduced and allowed it to decay there spontaneously. In four such experiments lithium was detected in the solutions, while blank experiments in which no emanation was used gave no indications of lithium. The experiments were then repeated with every possible precaution. It was found to be extremely difficult to get chemical products free from lithium. It is present in distilled water, and almost all reagents; and if a reagent does not contain it, and is allowed to remain some time in a glass vessel, it is then found to contain traces of the element. Water which had been distilled from platinum and gave no test for lithium upon evaporation, gave a distinct spectroscopic test for that element after it had stood for twenty-four hours in a glass flask. It was found that fused quartz also contains lithium, and therefore platinum was selected as the material in which the careful experiments were carried out. As a result of these experiments the investigators were unable to find any indication of the production of lithium by the action of radium emanation upon solutions of copper salts, and therefore they could not confirm Ramsay and Cameron's results.—Comptes Rendus.

The present-day conception of the protein molecule is that it is a complex of different amino acids variously joined together. By energetic hydrolysis of the protein the latter is naturally broken apart into simple fragments represented by the monoamino and diamino acids. When the hydrolysis is carefully conducted as by a weak solution of trypsin, various proteoses result as the primary products, i. e., high molecular polypeptides, which by further action of the enzymes may be successively broken down into simpler polypeptides, such as tetra-, tri-, and dipeptides. Fischer and Abderhalden a few years ago obtained a polypeptide in the pancreatic proteolysis of several proteins which was characterized by being composed solely of glycocoll, proline, and phenylalanine. More recently Osborne and Clapp obtained in the hydrolysis of gliadin what appeared to be a crystalline dipeptide composed of proline and phenylalanine. Further, Fischer and Abderhalden have just described several dipeptides obtained in the partial hydrolysis of proteins; notably, glycocoll and l-tyrosine from silk, glycocoll and l-leucine from elastin and l-leucyl-d-glutaminic acid from gliadin; all characteristic dipeptides. In these results we see suggested the possibility of a primary cleavage of proteins into dissimilar polypeptides and dipeptides with distinct chemical make-up. If such reactions as these do occur, under the influence, for example, of pepsin or trypsin proteolysis, or even through the agency of the duodenal enzyme erepsin, then it is certainly reasonable to consider whether the individual proteoses or polypeptides formed during gastric and pancreatic digestion may not be endowed with different physiological properties. It raises the question whether in the digestion of protein in the gastro-intestinal tract by the enzymes naturally present there a kind of selective cleavage may not occur, in which the various amino acids contained in the protein are split off in special combinations representative of particular lines of attraction or union. Further, a tendency toward the formation of di- and polypeptides having a definite composition, assuming it to exist, may furnish a clue to the way in which the synthesis of protein may be accomplished. Obviously, however, there remains to be discovered first the nature of the 29 to 46 per cent of the protein not yet represented by known decomposition products.

ENGINEERING NOTES.

The largest individual irrigable land holding in the West, the Southern Pacific's 350,000-acre tract, situated on the Truckee-Carson canals, thirty miles east of Reno, Nev., has been opened to settlement. The railroad will co-operate with the government in attracting settlers to the vast area. Thousands of acres that have remained undeveloped while other fertile spots in surrounding valleys were being reclaimed will now support families.

A striking series of experiments has been carried out at the National Physical Laboratory, at the instance of Sir John Brunner, to test the protective effect of cement concrete on steel; 8-inch specimens of mild steel bar, both turned and with the scale left on, were embedded in blocks of good Portland cement concrete measuring 12 inches by 7½ inches by 7½ inches. The blocks were covered with water several times a week for a year, and for three months afterward were left in the open exposed to the weather. After sixteen months one of the blocks has been broken up and the imbedded specimens examined. No trace of any action of the cement could be detected, the scale on the rough specimen was undisturbed, and the bright specimen showed no alteration on examination under the microscope. Further tests are to be carried out with the remaining blocks.

An interesting marine surgical operation is being completed in the Devonport dockyard of the British navy. Torpedo boat 99 foundered outside Plymouth, and the depth of water not being excessive, attempts to salvage the craft were made, which subsequently proved successful. Owing to its light construction, however, in the task of raising, the torpedo boat broke its back, the stern portion slipping back into the water. The cleavage occurred just abaft the engine room, and the severed portion weighed some 20 tons. Both halves were recovered, however, and conveyed to the dockyard. Examination showed that the astern portion in falling adrift suffered comparatively little damage, the most serious being the straining of the shaft brackets. The front half was practically sound. It was, therefore, resolved to rejoin the two parts. The shaft brackets were removed and new ones substituted. The bow section was taken into drydock and set up on the blocks ready to receive the stern half. The setting of this latter part, however, occasioned considerable difficulty, owing more especially to the light character of the plating. The whole mass had not only to be lifted, but also hauled a considerable distance over the side of the dock to the basin in which the bow portion was set up, and then sent down inclined planes to its requisite position. When set up on the blocks there was a gap of some six feet between the two sections where the plates had broken and let the boat fall in two. These were removed and new framing set in position, the gap being filled with new plating, so that when completed the craft will be as good as new.

In some quarters there has appeared a tendency to consider the internal-combustion motor as a rival to the steam-engine in the sense that one machine is destined to supplant the other. The mistake of this view, according to an editorial writer in Cassier's Magazine, is apparent if we consider the history of other departments of technical development and realize how each subject creates its own field and markets, by the side of those previously in existence. Electric lighting has not displaced gas, but rather stimulated improvements which have vastly developed the fields for both systems. Steam has grown up side by side with hydraulic power, and both are valued and active servants of mankind. So far as the gas-engine is concerned, it is beginning to be realized that for very large units, in which all the modern methods of attaining efficiency are practicable, the steam plant can generate power at a cost which leaves little or no margin for successful rivalry by the gas-engine. The principal field for the large gas-engine at the present time appears to be in connection with the utilization of waste furnace gases, rather than with independent producer plants. When we come to engines of moderate size, however, the real commercial field of the gas-engine appears, since it is in this department of power production that the economy of the steam-engine falls off, while that of the gas-engine remains almost, if not quite, as high as in the larger sizes. For the small power plant in which the suction producer can be combined with the engine to form a complete unit, the fuel economy is far ahead of anything that can be attained with a steam plant of the same power, and in this very large market there is abundant opportunity for commercial development and for the extension of power machinery in many minor industries.

TRADE NOTES AND FORMULÆ.

Diamond Cement.—Mix of washed chalk and litharge, each 15 parts, with 50 parts of finely pulverized graphite, and add sufficient linseed oil varnish to make a plastic mass.

Deodorant.—Rosin, with some camphor, is dissolved in oil of turpentine, the mixture is mixed with rosin oil, and exposed at 140 deg. F. for twenty-four hours, in a current of air, being thereby oxidized. By the addition to it of lime or sawdust a solid product is obtained.

Diamond Ink for Writing on Glass.—Three parts of barium sulphate and 1 part fluoride of ammonia are mixed together in a leaden dish and enough sulphuric acid added to decompose the fluoride of ammonia and form a semi-fluid mixture. This is transferred either to a glass coated by pouring with paraffine or to a gutta-percha or lead receptacle and is applied to the glass with a pen.

Diorrexin, a blasting material, consists, according to the analysis of Fels, of the following ingredients, calculated according to dry material:

Picric acid	1.50	1.65
Wood charcoal	6.82	7.49
Beechwood sawdust	9.98	10.97
Nitrate of potash	38.93	42.78
Nitrate of sodium	21.07	23.16
Sulphur	12.20	13.40
Water	9.00	——
Loss	0.50	0.55

Equal volumes of diorrexin and aeraric blasting powder are capable of exercising the same explosive effect. Owing to the fact that diorrexin is 25 volumetric per cent lighter than the other blasting material and costs one-fifth less, diorrexin is to be preferred to black blasting powder.

Treatment of Cork Stoppers.—The Verband Deutscher Korkindustriellen gives the following directions: Storage: The storage place must be dry, because in a damp place the corks absorb the moisture and in consequence mold, thereby acquiring a disagreeable flavor and giving off a musty odor. Before use, place the corks in a clean basket, woven of peeled willow and lined with clean packing cloth. Every half hour sprinkle them by means of a sprinkling can with clean cold water, shaking the basket vigorously before each sprinkling. The corks, treated in this manner, form in every respect a perfect bottle closure. Particular care must, however, be taken that the corking machine is absolutely clean and the scalding of the corks must, under all circumstances, be avoided. As far as cork flavor is concerned the above association pledges its members, under no circumstances, to allow their customers any rebate, on account of so-called cork flavor, or to make them any allowance therefor in any form, for it is certain that the actual "cork flavor" is a rare phenomenon which, however, when it occurs must be considered as unavoidable, and must be so regarded. Almost invariably the so-called cork flavor may be traced to mishaps, the prevention of which is not within the power of the cork merchant, but devolves upon the cork consumer. While, in many instances, the place where the corks are stored is unsuitable, being damp and close, whereby the corks become moldy and musty, in other cases the corking machine is not clean enough. In most cases, however, the corks are wrongly handled before use, i. e., they are often steeped in warm, frequently even in hot, water, and that is wrong. Apart from the fact that such treatment causes the corks to lose elasticity the warm or hot water dissolves the tannic acid in the cork substance and the cork, soaked full of water, not only pours into the contents of the bottle, when pressed into the bottle neck by means of the corking machine, a turbid fluid, but also a part of its tannic acid. The still widely practised custom of steeping corks in hot water before use is therefore wrong.

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